MECHANICAL ENGINEERING

Design Considerations Associated With Large Aluminum Forgings . . . . . *C. W. Andrews* 777

Organization for Production Engineering . . . *R. H. McCarthy* 785

High-Altitude and Speed Propulsion Wind Tunnel . . . *F. L. Wattendorf, J. Noyes, and A. I. Ponomareff* 789

Machining of High-Tensile-Strength Steel . . . *F. M. Rayburn* 794

Explorers and Creators . . . . . *L. A. DuBridge* 796

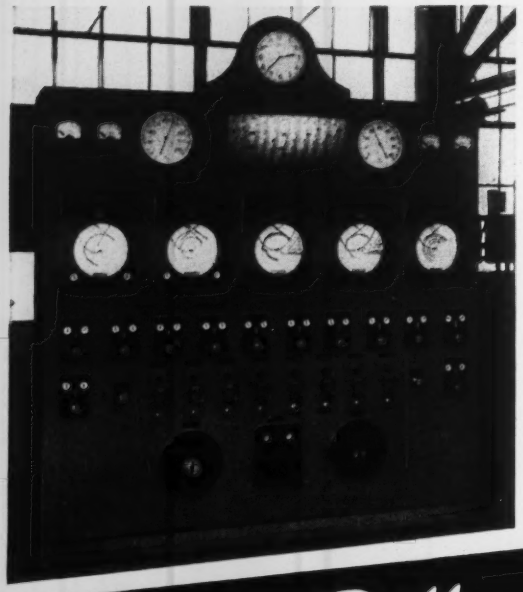
Engineering Mode of Analysis . . *G. A. Hawkins and L. M. K. Boelter* 799

Bearings, Lubricants, and Lubrication 801

Departments

Briefing the Record, 809
ASME Technical Digest, 818
ASME News, 836
Keep Informed—Adv. Page 41

Tentative Program—ASME 1953 Annual Meeting—See pages 836-841



This Bailey Boiler Control Panel in a mid-western industrial plant saves fuel and insures safe operation of a 100,000 lb per hr, 175 psi, sat., pulverized coal and gas-fired boiler.

What's Your Control-Dollar Efficiency?

Control-dollars frequently bring annual investment returns of 100% or more. When you buy adequate, well-applied steam plant controls, you increase your dollars' ability to work usefully for you.

That's where Bailey can help: Bailey Controls can give you a better control-dollar efficiency. Here's why:

1. **Complete Range of Equipment—fully co-ordinated.** You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, just because he has a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control systems.

2. **Engineering Service—backed by experience.** No other manufacturer of instruments and controls can offer as broad an experience, based on successful installations involving all types of combustion, flow measurement and automatic control.

3. **Direct Sales-Service — conveniently located near you.** Bailey Meter Company's sales-service engineers are located in more industrial centers than those of any other manufacturer of boiler control systems; you get prompt, experienced service with a minimum of travel time and expense.

•

For better control-dollar efficiency—for more power per fuel dollar, less outage and safer working conditions, you owe it to yourself to investigate Bailey Controls. Ask a Bailey Engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record: "More power to you!"

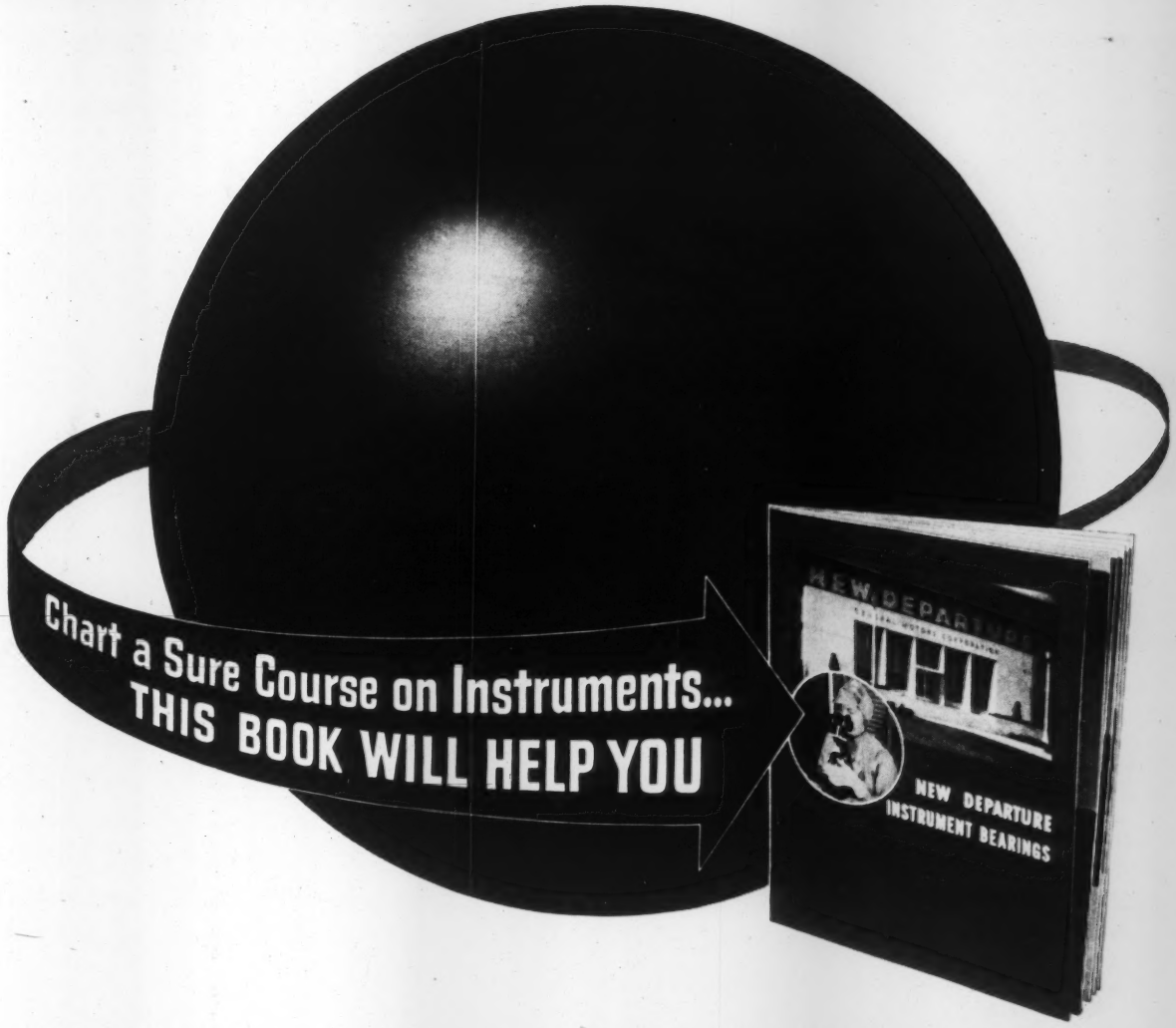
A-112-1

BAILEY METERS

BAILEY METER COMPANY

1026 IVANHOE ROAD
CLEVELAND 10, OHIO

Controls for Steam Plants
COMBUSTION · FEED WATER
TEMPERATURE · PRESSURE
LIQUID LEVEL · FEED PUMPS



Strict quality control keynotes every step in the manufacture of New Departure instrument bearings. The book pictured above takes you through New Departure's instrument bearing manufacturing facilities, showing the measures taken to achieve the closest possible approach to perfection. You'll see that New Departure enforces the most exacting standards—from raw material to finished product, to bring you the very finest bearing for *every* instrument application.

If you design or manufacture products demanding high-precision instrument bearings, this book will interest you. Write for your copy—and for the complete instrument bearing catalogue—to New Departure, Bristol, Conn.

NOTHING ROLLS LIKE A BALL

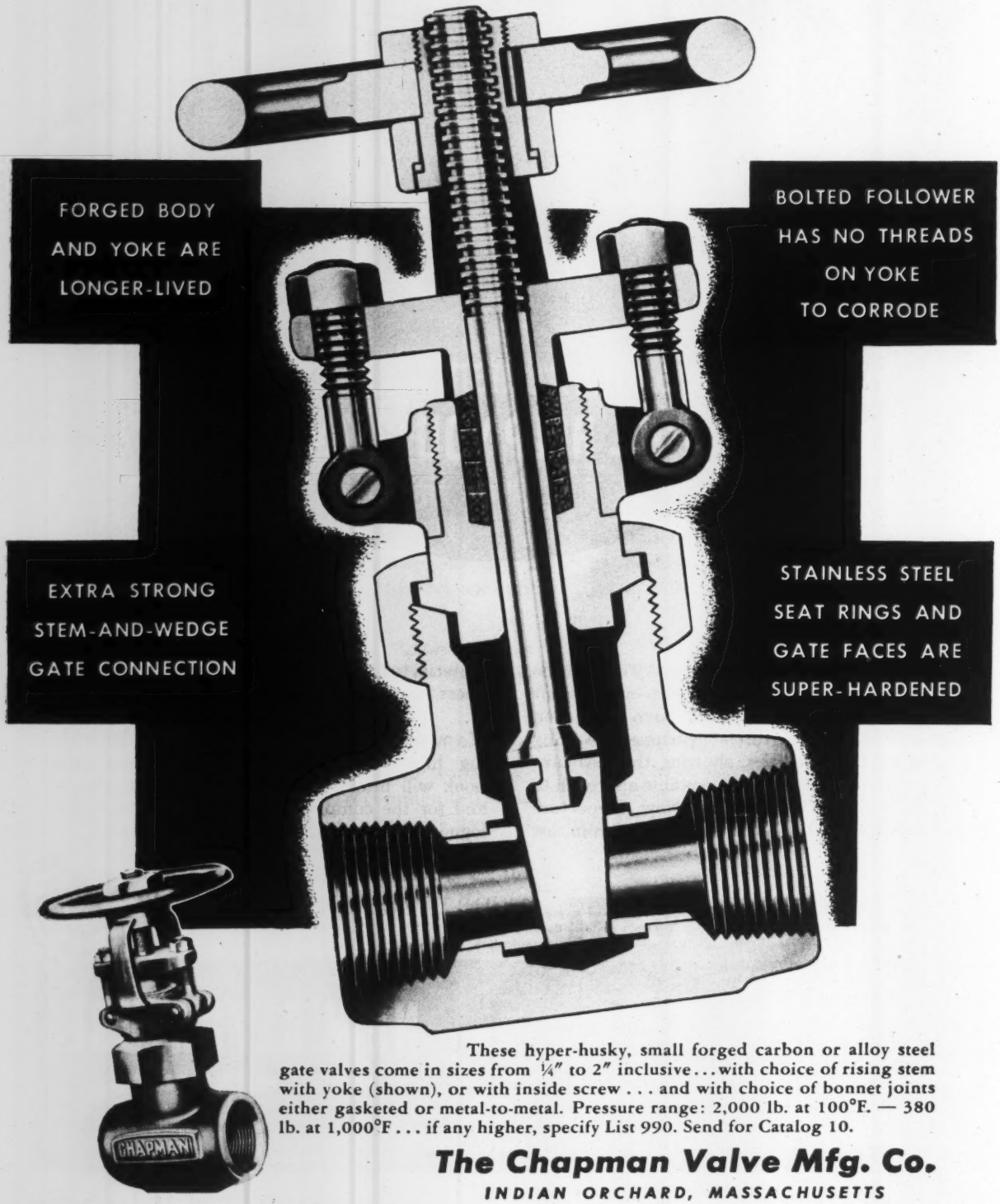
Automatic torque testers measure starting characteristics of every low-torque bearing. It is just one of many exacting control devices developed by New Departure engineers specifically for instrument bearing manufacture.

NEW DEPARTURE
BALL BEARINGS

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT
Also Makers of the Famous New Departure Coaster Brake

MECHANICAL ENGINEERING, October, 1953, Vol. 75, No. 10. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members and affiliates one year $3.50, single copy 50¢; to nonmembers one year $7.00, single copy 75¢. Postage to Canada, 75¢ additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations.

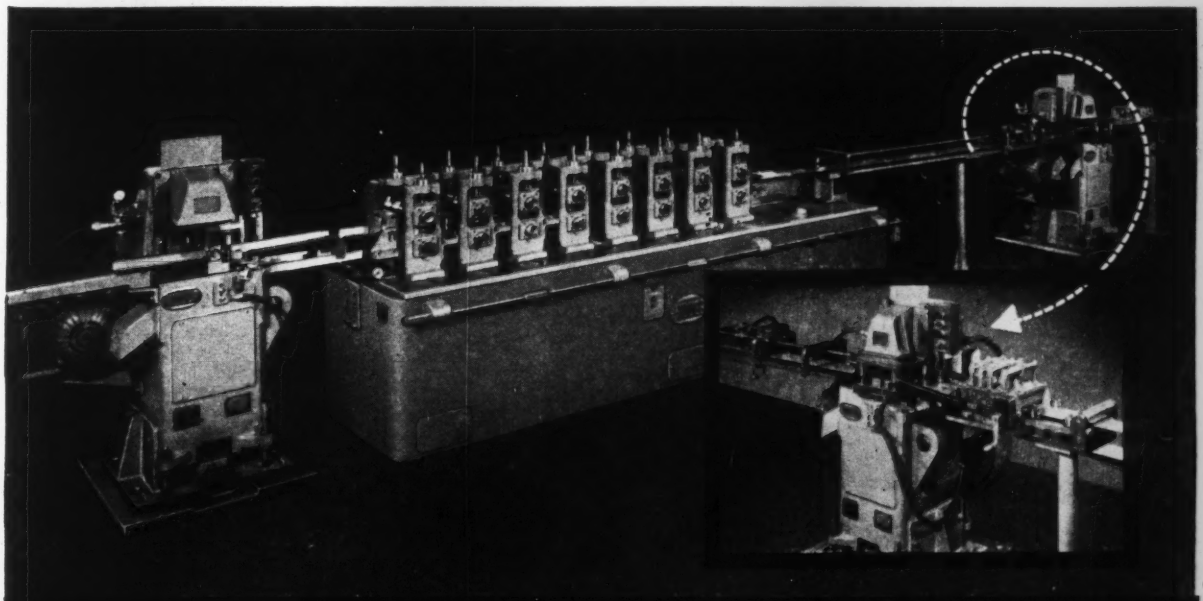
Here's where CHAPMAN LIST 960... gets all that Extra Strength


FORGED BODY AND YOKE ARE LONGER-LIVED
BOLTED FOLLOWER HAS NO THREADS ON YOKE TO CORRODE
EXTRA STRONG STEM-AND-WEDGE GATE CONNECTION
STAINLESS STEEL SEAT RINGS AND GATE FACES ARE SUPER-HARDENED
CHAPMAN

These hyper-husky, small forged carbon or alloy steel gate valves come in sizes from ¼″ to 2″ inclusive... with choice of rising stem with yoke (shown), or with inside screw . . . and with choice of bonnet joints either gasketed or metal-to-metal. Pressure range: 2,000 lb. at 100°F. — 380 lb. at 1,000°F . . . if any higher, specify List 990. Send for Catalog 10.

The Chapman Valve Mfg. Co.

INDIAN ORCHARD, MASSACHUSETTS



COLD-ROLL-FORMING

Multi-Function Production Lines *engineered to fit your needs*

The continuous feeding of coiled strip into a Yoder Cold-Roll-Forming machine is the fastest, most accurate and economical method yet devised for converting flat rolled metal into a multitude of finished shapes.

For still greater economy other operations may be combined with cold forming, such as embossing, notching, punching, perforating and cutting-to-length, coiling etc., often without adding a single penny to the labor or handling cost.

Some of these operations can be done by means of special tooling in the roll forming machine itself, others by auxiliary units lined up with it. Shown above is a line consisting of: (1) a Yoder Automatic Press for notching or perforating the strip before it goes into the forming machine, (2) the forming machine, and (3) another Yoder Press for automatic cut-off. The finished pieces from this line are then ready for assembly into window louvres or jalousies.

The know-how of the Yoder engineering staff is at your service in designing such multi-function production lines to meet individual requirements. Tell us about your needs. Yoder Book on Cold-Roll-Forming and auxiliary operations sent on request.

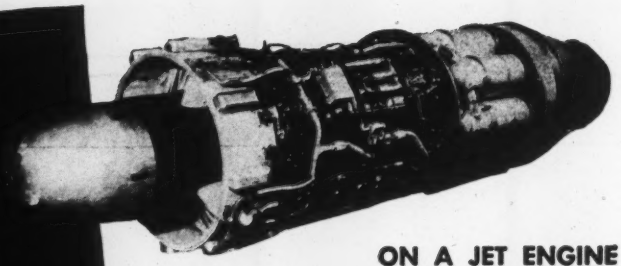
THE YODER COMPANY • 5549 Walworth Ave., Cleveland 2, Ohio

Complete Production Lines

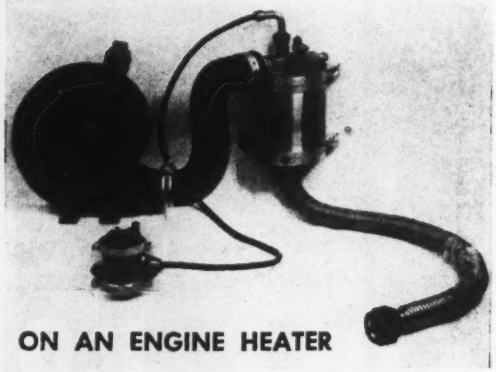
- ★ COLD-ROLL-FORMING and auxiliary machinery
- ★ GANG SLITTING LINES for Coils and Sheets
- ★ PIPE and TUBE MILLS—cold forming and welding

ENGINEERING YODER MANUFACTURING

CMH FLEXIBLE METAL HOSE answer to 1001 design problems . . .

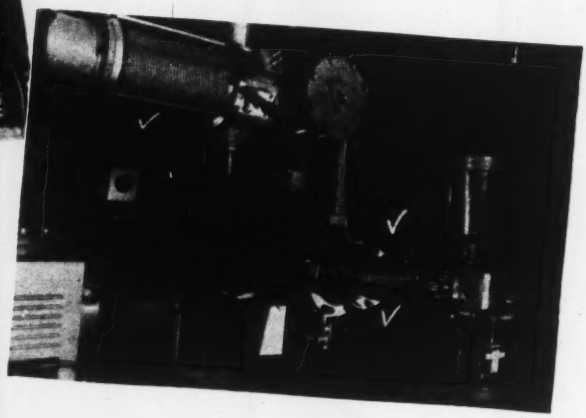


ON A JET ENGINE
(Photo courtesy, General Electric Co.)



ON AN ENGINE HEATER

ON A RECORD-HOLDING RACE CAR
(Photo courtesy, Cummins Engine Co.)



ON A POSITIVE ION ACCELERATOR
(Photo courtesy, High Voltage Engineering Corp.)

The Flexible Metal Hose Design Guide gives detailed data on types, sizes and characteristics of CMH hose. Write for your copy today, or see complete hose specifications in Sweet's Product Design File.

In any product where liquids or gases must be conveyed under conditions of vibration, expansion and contraction, misalignment or flexation, there is a design problem that can be answered with CMH Flexible Metal Hose.

CMH Flexible Metal Hose is available in a variety of corrugated and convoluted types, in steel, bronze, stainless steel and other alloys and in a complete range of diameters for every application. Whatever your product, if motion or misalignment exists in fluid conveying lines, it will pay you to consider CMH Flexible Metal Hose. Just send an outline of your problem and we will make recommendations.

CHICAGO METAL HOSE Division

Flexonics *Corporation* 1305 South Third Avenue, Maywood, Illinois

In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

Flexon identifies CMH products that have served industry for over 50 years.

® CMH

Flexible metal hose

Expansion joints.

Aircraft components

Metallic bellows

Consider the Atomic Power Plant...

when critical piping is the order!

TODAY'S OPERATING TEMPERATURES and pressures so closely approach the maxima for available piping materials that nothing can be left to chance . . . to empirical design. And detailed mathematical calculations to determine all the stresses in a modern, complicated piping system is a herculean task.

However, Kellogg's model tester, employing patented electrical measuring heads (illustrated) fulfills the need for rapid, exact testing for all forces and moments in a proposed system. An added advantage in this method is that changes in design indicated during testing can be immediately incorporated in the model—and testing continues reflecting the effect of the changes in design on all other phases.

While Kellogg's model tester has been used primarily on central station systems (piping arrangements for a total of some 4,700,000 KW's have been investigated to date), it is no wonder that the equipment was again called upon when the power plants for the first atomic submarines were being designed.

All the facets of these extremely critical piping systems—considerably complicated by the confined space within submarines—were thoroughly checked and rechecked on the model tester to assure the operational soundness of the design.

This approach to the problems of high-pressure, high temperature piping—the desire to be sure, to explore new testing techniques, and to constantly improve welding procedures—is Kellogg's basic stock in trade. Many power station designers and utility companies also say it's the basic reason why they repeatedly specify *"critical piping by Kellogg."*

NEW K-WELD PROCESS . . .
Send for descriptive literature about the new K-Weld process which assures complete penetration without the use of backing rings.

These leading companies are among the many major producers of power who use M. W. KELLOGG POWER PIPING . . .

- Niagara Mohawk Power Corp.
- Palestine Electric Corp., Ltd. (Israel)
- Philadelphia Electric Co.
- Public Service Co. of Northern Illinois
- Public Service Electric & Gas Co. of N. J.
- Societe Anonyme John Cockerill (Belgium)
- Societa Edison (Italy)
- Societe Financiere De Transports Et D'Entreprise Industrielles (Sofina) (Belgium)

OTHER FABRICATED PRODUCTS including: Pressure Vessels . . . Vacuum Vessels . . . Fractionating Columns . . . Drums and Shells . . . Heat Exchanger . . . Process Piping . . . Bends and Headers . . . Forged and Welded Fittings . . . Concrete and Radial Brick Chimneys

FABRICATED PRODUCTS DIVISION
M. W. KELLOGG

KELLOGG — SUBSIDIARY OF PULLMAN INCORPORATED

KELLOGG
HIGH TEMPERATURE
HIGH PRESSURE
POWER PIPING
KELLOGG
HIGH TEMPERATURE
HIGH PRESSURE
POWER PIPING
KELLOGG
HIGH TEMPERATURE
HIGH PRESSURE
POWER PIPING
KELLOGG
HIGH TEMPERATURE
HIGH PRESSURE
POWER PIPING

The barrel that's rolling for industry... NEW H
H
HYATT BEARINGS DIVISION, GENERAL MOTORS CORPORATION

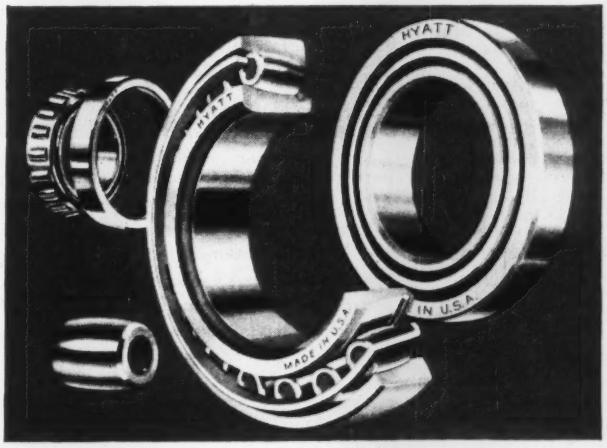
YATT BARREL BEARING

now available in volume!

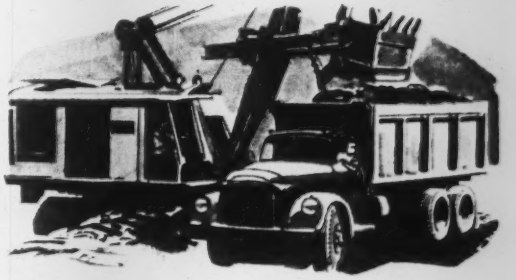
Hyatt is rolling out the barrels! . . . and a familiar shape is giving a big lift to modern industry! A new Barrel Bearing —pioneered and perfected by Hyatt—is available in volume for the first time! There's no other bearing quite like it—and it's ready for a starring role in industrial production!

The Barrel name comes from the barrel shape of the rollers . . . but its superiority in bearing applications comes from *dual-purpose design* and *self-aligning ability!* This unique bearing takes load from any direction . . . and operates at full load-carrying capacity under conditions of misalignment! And in addition, the barrel shape of the rollers combines the low rolling friction of a ball with the high load capacity of a cylindrical roller—so that the Barrel Bearing is ideal for a wide range of applications.

Expensive? *Not at all!* Advanced manufacturing processes —plus the facilities of one of the newest and finest bearing plants in the world—make the initial cost far lower than you would expect! . . . For full information on this newest solution to the friction problem, write to the address below.



Self-aligning action makes the Barrel Bearing ideal for tractors and farm implements. Over many years, its durable, dependable performance has been established in a wide range of these applications.



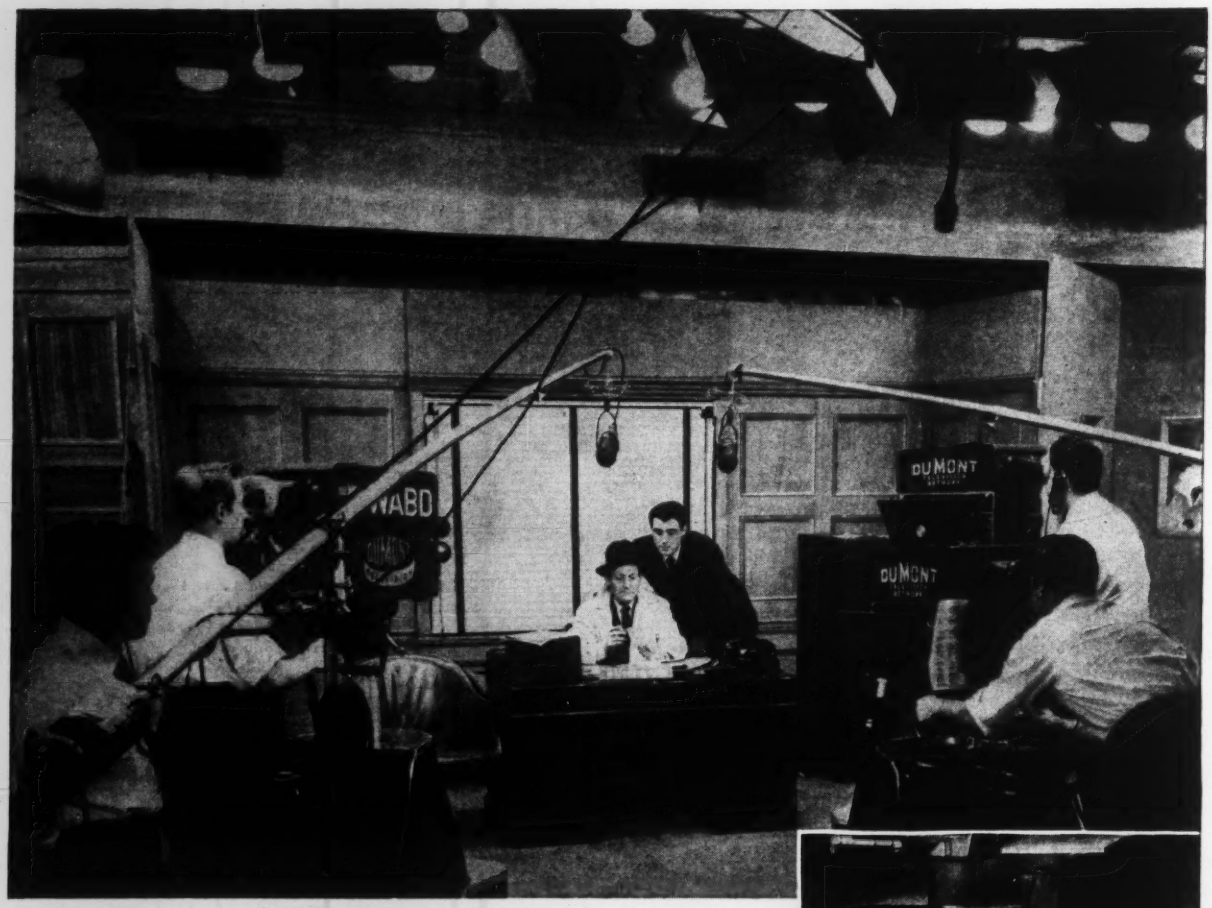
In trucks and construction equipment, too, Hyatt's Barrel Bearing operates with full efficiency under conditions of heavy, multiple-direction loading. Unique roller and race design distributes the load over large areas of contact.

Hyatt's new plant, in Clark Township, N. J., is among the most modern in the world. New equipment makes possible advanced manufacturing processes, and research facilities are the finest in the bearing industry.

YATT

ROLLER BEARINGS

HARRISON, NEW JERSEY



Putting Air to work for DuMont: Air conditioning must absorb the heat of powerful overhead lights. But it must be *quiet*.

ON THE AIR

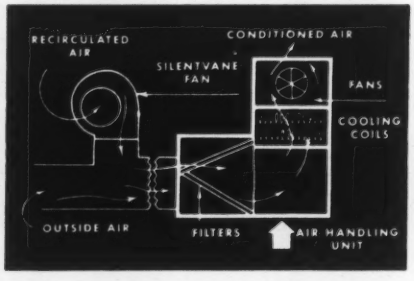
EQUIPMENT NOISE IS NOT IN THE SCRIPT

Television won't tolerate noisy equipment. Super-sensitive mikes pick up and magnify every whisper. They have to because they must keep out of camera range—often 5 to 10 feet from the actor's lips. Equipment which raises the general sound level cannot be used.

Yet these closed-in studios with their high heat loads must be air conditioned. That's why silent Westinghouse fans and air handling units were chosen for the DuMont Network's New York Tele-Centre. *Every minute* 160,000 cubic feet of conditioned air is supplied noiselessly.

If you are interested in quietness—or efficiency, or dependability—when it comes to *putting air to work*, come to Westinghouse. A complete line of air handling, air conditioning and air cleaning products means undivided responsibility. Ask us for General Catalog 600. Call your local office, or write: Westinghouse Electric Corporation, Sturtevant Division, Hyde Park, Boston 36, Massachusetts.

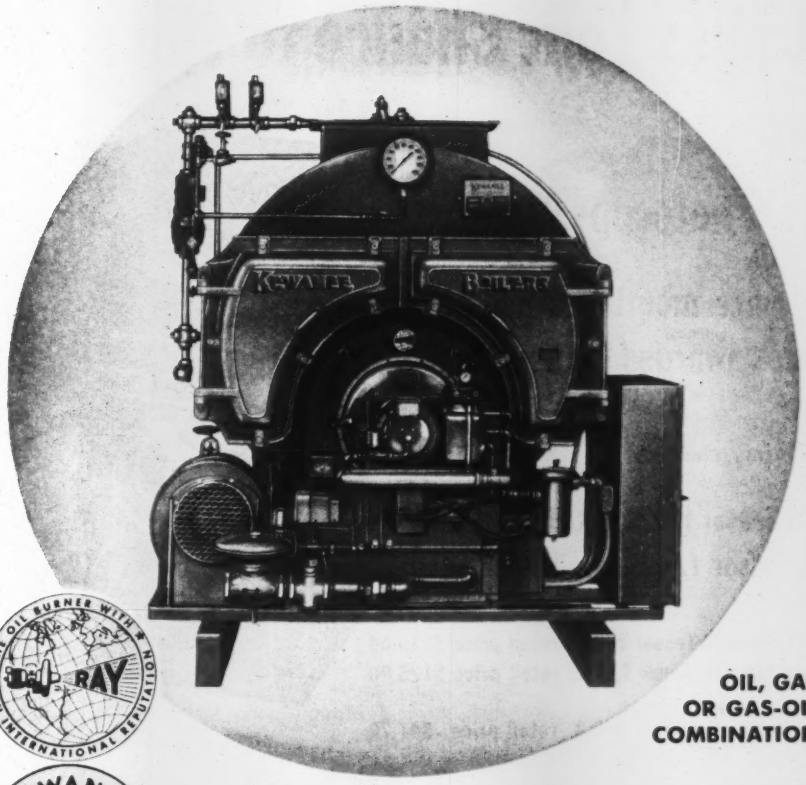
Here's the equipment which conditions the air. At left, one of many silent Westinghouse fans pulls heat-laden air from the station. At right, one of the "packaged" Westinghouse air handling units filters the air, cools, dehumidifies, and returns it. These factory-assembled units give quiet, dependable performance—with a single manufacturer's warranty.



WESTINGHOUSE AIR HANDLING

YOU CAN BE SURE IF IT'S Westinghouse

J-80312



OIL, GAS
OR GAS-OIL
COMBINATION

A real advance in steam generation

KEWANEE-RAY
BOILER-BURNER UNIT

Produce steam more economically, more efficiently, with the new Kewanee-Ray Boiler-Burner Unit. Use heavy catalytic residual fuel oils or light oils in combination with high or low pressure gas in a single unit!

New multi-stage, forced draft, secondary air control on the burner provides a constant velocity air stream to the combustion zone. Resulting high turbulence, high turndown ratio and high CO_2 content give you high combustion efficiency.

Quickly Installed . . . Simple to Operate. Matching connections are provided so that when the boiler and burner are brought together they can be easily connected with a minimum of field effort. A flip of the switch and the unit goes to work on either oil or gas. To change fuels, flip the switch again. *That's all.* Fully automatic operation throughout.

The Kewanee-Ray Boiler-Burner Unit is *complete.* Boiler, burner, all automatic controls and accessories as specified. No special foundation is required. All refractories are integrally mounted at the factory. And a built-in forced-draft fan eliminates need for high stacks.

For High or Low Pressure Steam or Hot Water Heating. High pressure units, for 1350 to 15,800 lbs. of steam per hour developing 39 to 456 horsepower at 125 and 150 psi. Low pressure units for 15 lb. steam or 30 lb. water rated at 1,313,000 to 15,300,000 btu.

The complete boiler is shipped from Kewanee, the burner including windbox and control panel from Ray...so each shipment can be timed to arrive when you want it. The boiler should be on the job site before the new plant walls are up. (Exposure to weather does no harm). The shipment of the burner can be delayed until the new building is enclosed. Arrival of unit in two separate shipments is another important advantage when Kewanee-Ray is specified.

RAY OIL BURNER COMPANY 1305 San Jose Avenue, San Francisco, California

KEWANEE-ROSS CORPORATION 106 Franklin Street, Kewanee, Illinois

Please send me your 16-page KR-1031 Catalog giving complete description and specifications on your Boiler-Burner Unit.

NAME_____

ADDRESS_____

CITY_____ STATE_____

Don't Miss Your Chance to Win a Fine Camera

Enter the Peerless Photocopy Contest

Only two more months. Complete set of prizes awarded both months

1st PRIZE Your choice of:

Contessa 35 Tessar f/2.8, retail price $216.00
Ikoflex IIa Tessar f/3.5, retail price $216.00

2nd PRIZE (choice) **Contina I Tessar f/2.8, retail price $119.00**
Ikoflex Ia Novar f/3.5, retail price $125.00

3rd PRIZE **Nettar IIc Novar f/6.3, retail price $41.70**

1st Prize – Contessa 35
An outstanding 35 mm camera with 45 mm Zeiss Opton coated Tessar f/2.8 lens. Automatically focused by a built-in combined view- and range-finder. Has built-in photo-electric exposure meter. Synchro Compur shutter is fully synchronized. Speeds from 1 to 1/500 sec.

1st Prize—Ikoflex IIa
A truly fine reflex camera with Zeiss Opton coated Tessar f/3.5 lens, in Synchro Compur fully synchronized shutter. Speeds from 1 to 1/500 sec.

The cameras listed above will be sent to the winners of this contest at absolutely no cost. All cameras come complete with top-grain leather carrying cases. All carrying charges prepaid.

HERE'S HOW YOU CAN WIN

The contest is open to everyone actively interested in industrial photocopy.

Write a report on one of the photocopy applications or photocopy techniques that you find most valuable in your business. There is no limit to the length of your report. It can be supplemented with examples of the result achieved, sketches of the process, anything which you feel will lead to a full appreciation of your use of photocopy. Although originality is important, the significance of the result achieved will determine the winners.

Example: Suppose you use photocopy to eliminate certain drafting steps such as the redrawing of an entire part in order to make a simple change. Tell in your report exactly what steps you take to get the desired result. Tell also what this means to your drafting department in terms of time saved. Name the paper and machines involved in your process, and tell why you use them. Remember, the more complete and understandable your report, the better your chance to win.

Only two months left!

DON'T DELAY!
Send your report to:

To qualify for this month's awards, entries must be postmarked no later than November 10, 1953.

To qualify for next month's awards, entries must be postmarked no later than December 10, 1953.

THE JUDGES

The contest will be judged by the executive board of Industrial Photography magazine: Ben Zale, Editor; Lloyd E. Varden, Scientific-Technical Editor; David B. Eisendrath, Jr., Technical Editor. The winners will be reported after each closing date.

YOUR REPORT IS A VALUABLE CONTRIBUTION TO THE INDUSTRY

We are planning to publish the winning reports as a portfolio of modern photocopy practices. The purpose of this portfolio will be to show how valuable photocopy is as an industrial tool, and as evidence of what is being done by experts in the field. No report will be published in the portfolio, or used in any other advertising or promotional material without your written permission and that of the company involved.

PEERLESS PRODUCTS

Peerless is one major manufacturer in the field whose production and development facilities are devoted exclusively to industrial, scientific and commercial photo-reproduction. The entire Peerless line of photocopy papers and machines is sold only through a network of factory distributors who are skilled photocopy specialists. Complete literature on all Peerless products is yours for the asking.

PEERLESS PHOTO PRODUCTS, INC.

Shoreham, Long Island, N.Y.

Manufacturers of Quality Photocopy Papers and Special-purpose Industrial Photocopy Equipment

"WHY DON'T YOU TRY AETNA? YOU'LL BE SURPRISED AT THEIR VERSATILITY"

Yes, Aetna *is* versatile. For 37 years Aetna has been making original equipment bearings and precision parts for the nation's leading manufacturers in the automotive, farm implement and general industrial fields.

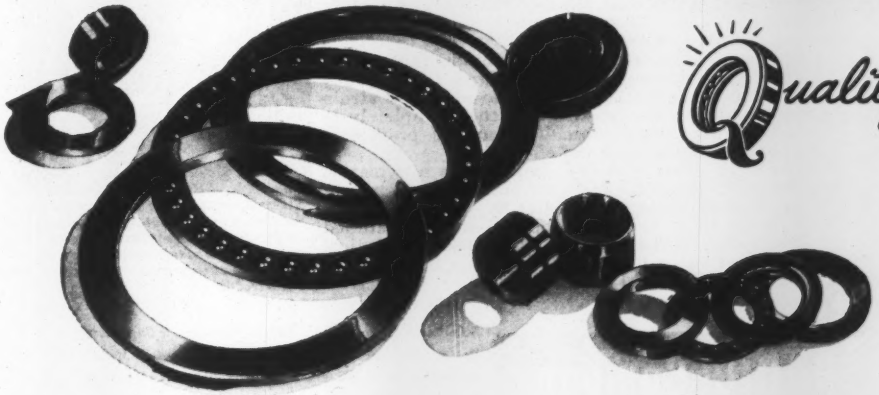
From conventional light duty thrust bearings in 1916, Aetna's versatility has grown to include all-type-all-duty ball thrust bearings, roller bearings and vital parts spanning an incredible range of industrial applications.

It's worth remembering—Aetna's diversified usefulness to industry—Aetna's reputation of producing to the stiffest tolerances known to the industry.

If you are having bearing or parts troubles—if you need a more versatile, more dependable supplier, consider Aetna. Your satisfaction is assured by the fact that 80% of our business comes from firms we have served for 20 or more of our 37 years. Write! Just state your problem, send your prints, or ask that a near-by representative drop in. No obligation. Aetna Ball and Roller Bearing Company. 4600 Schubert Avenue, Chicago 39, Illinois.

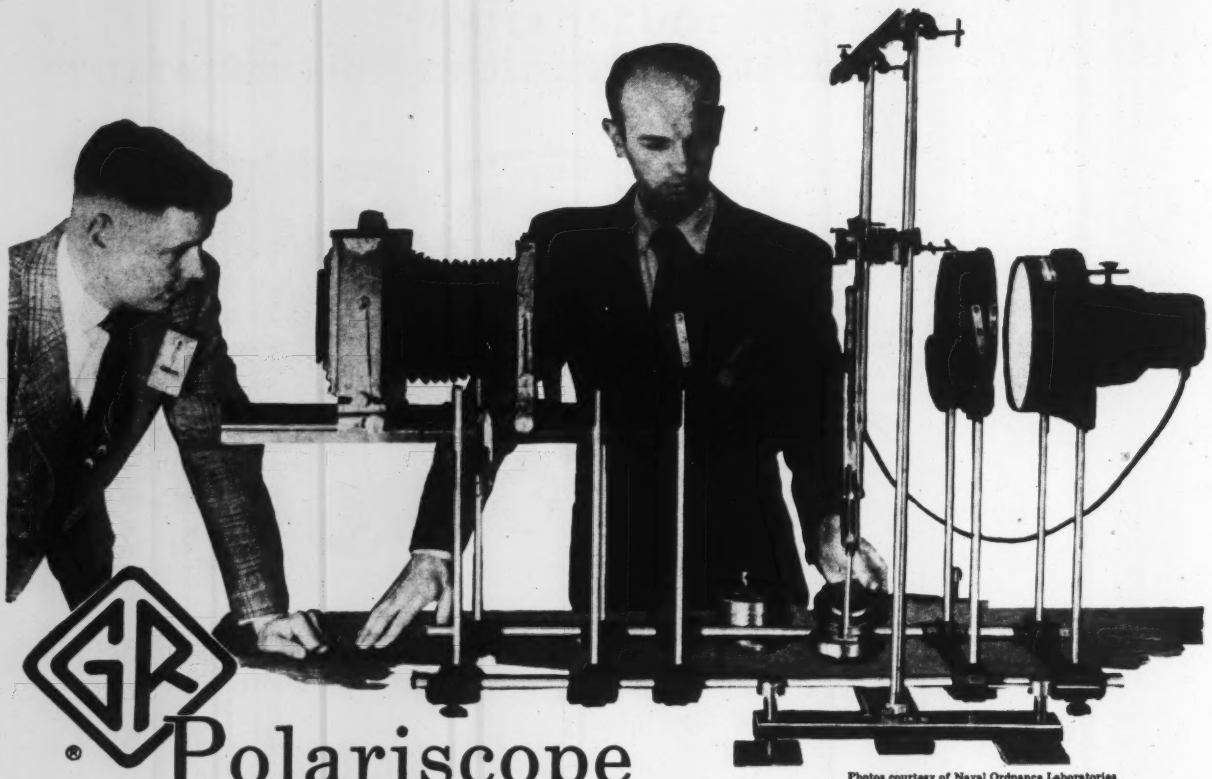
Aetna

BALL AND ROLLER BEARINGS • MISCELLANEOUS PRECISION PARTS



Quality since 1916

BRANCH OFFICES COAST-TO-COAST: • Albany • Atlanta • Auburn • Baltimore • Binghamton • Birmingham • Boston • Bridgeport • Buffalo • Charlotte • Chicago • Cincinnati • Cleveland • Denver • Detroit • Hartford • Houston • Jacksonville • Los Angeles • Newark • New York • Niagara Falls • Philadelphia • Pittsburgh • Providence • Richmond • Rochester • San Francisco • Seattle • Syracuse • Trenton • Utica • Waterbury • Worcester. *See your classified 'phone directory for addresses.*



GR® Polariscope

Photos courtesy of Naval Ordnance Laboratories

Simplifies Supersonic Wind-Tunnel Studies

The First Announced Application of Photoelastic Techniques to Wind-Tunnel Balance Design

The G-R Type 1534-A Polariscope reveals stresses in transparent, photoelastic models when they are observed under a steady polarized light. With high-intensity, short-duration flash illumination such as supplied by the G-R Type 1532-B Strobolume, dynamic stresses can be photographed as well. Both methods have been successfully applied by the Aeroballistics Design and Operations Division of the Naval Ordnance Laboratory to problems associated with supersonic wind-tunnel balances.

Finger points to location of axial-force balance section in supersonic model.

Wind-Tunnel balances are inserted internally in models to be placed in controlled airstreams. Electrical strain gages are cemented to sections of the balance structure so that acting aerodynamic forces and moments may be measured. A primary problem in obtaining accurate measurements lies in properly designing the balance structure. Another difficulty is the exact locating of strain gages on the balance so that all six force and moment components will be accurately indicated without mutual interaction among components.

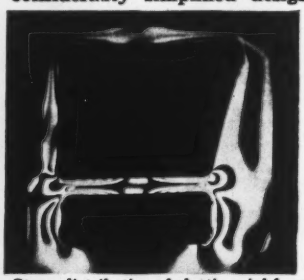
Before the development of the photoelastic technique, both problems had to a large extent been handled emperically. Optimum balance design and gage placement are too complex for ordinary analytical stress studies. The Polariscope now enables accurate visual or photographic investigations which have considerably simplified design and measurements.

A transparent model of the balance is examined in the G-R Polariscope's field of polarized, monochromatic light under loading conditions which will be encountered in the wind tunnel. The black and white fringes recorded photographically through the Polariscope are then interpreted qualitatively to give a complete picture of the stress distribution of the model.

The stress pattern enables the designer to accurately design the balance structure and to place the strain gages where the stresses will be either completely in tension or in compression. This avoids previously troublesome cancellations of effects.

The G-R Type 1534-A Polariscope is a versatile, lightweight, portable and convenient-to-use instrument, moderately priced at $490.00.

Write for the G-R Polariscope Bulletin for a detailed description of the powerful photoelastic analytical method . . . a technique which can be of use to every structural-design engineer.



Stress distribution of plastic axial-force section under simulated air load applied by the Polariscope straining members. Photograph was taken with conventional camera equipment through the Polariscope.

GR®

GENERAL RADIO Company

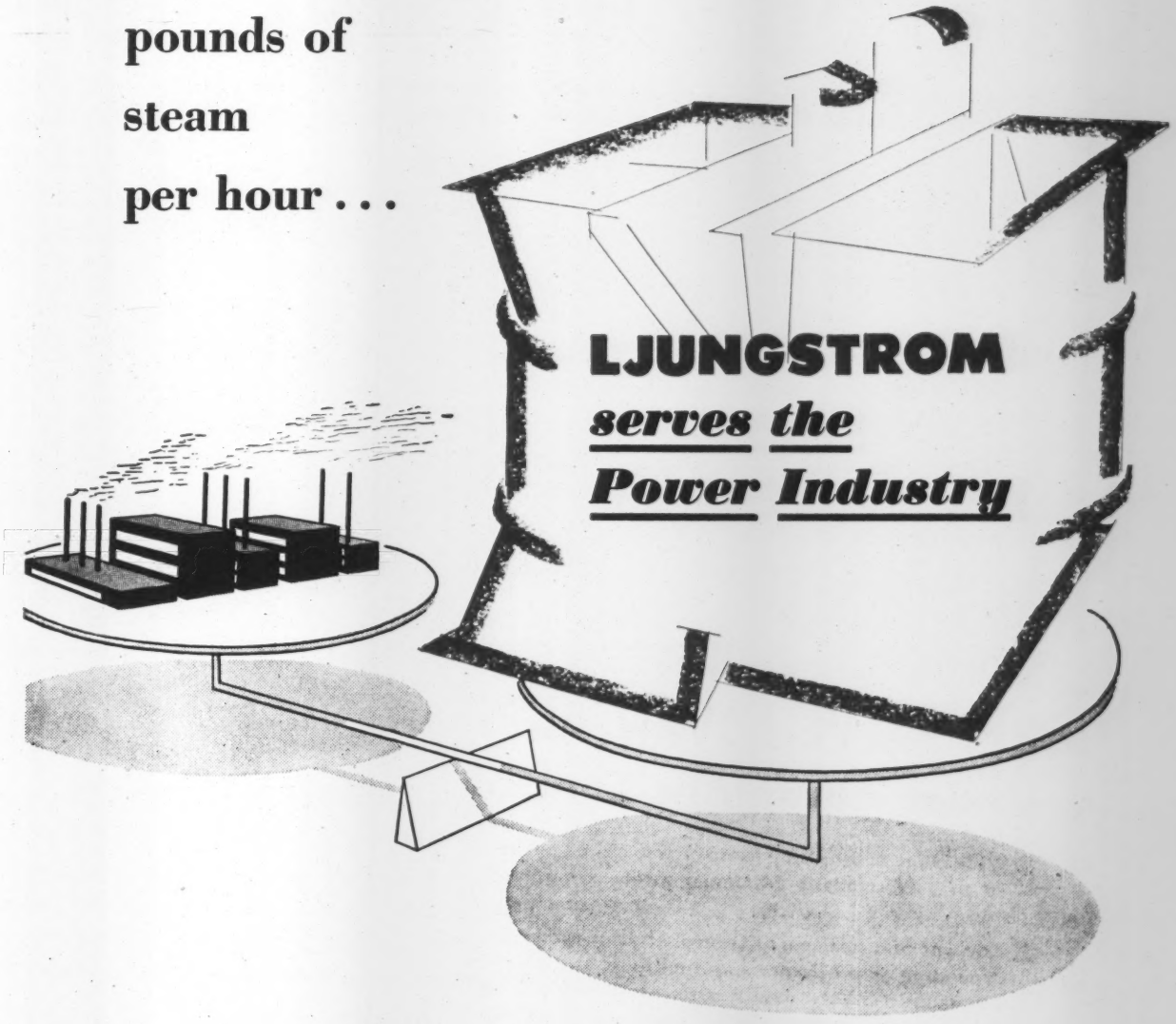
275 Massachusetts Avenue, Cambridge 39, Massachusetts, U. S. A.

NEW YORK 6 · CHICAGO 5 · LOS ANGELES 38

Admittance Meters ☆ Coaxial Elements ☆ Decade Capacitors
Decade Inductors ☆ Decade Resistors ☆ Distortion Meters
Frequency Meters ☆ Frequency Standards ☆ Geiger Counters
Impedance Bridges ☆ Modulation Meters ☆ Oscillators
Variacs ☆ Light Meters ☆ Megohmmeters ☆ Motor Controls
Noise Meters ☆ Null Detectors ☆ Precision Capacitors
Pulse Generators ☆ Signal Generators ☆ Vibration Meters ☆ Stroboscopes ☆ Wave Filters
U-H-F Measuring Equipment ☆ V-T Voltmeters ☆ Wave Analyzers ☆ Polariscopes

347,000,000

pounds of steam per hour . . .



In the post-war rush to expand power generating facilities, utilities have not lost sight of the need for *operating economy*. Increasingly over these years, the fuel-saving, performance-improving potentials of the Ljungstrom Air Preheater have been realized – until today, nearly two out of every three power boilers are ordered with the specification "Ljungstom Air Preheater."

Since 1946 alone, in fact, more than 347,000,000 pounds per hour of steam capacity – installed or on order – have been designed for Ljungstrom.

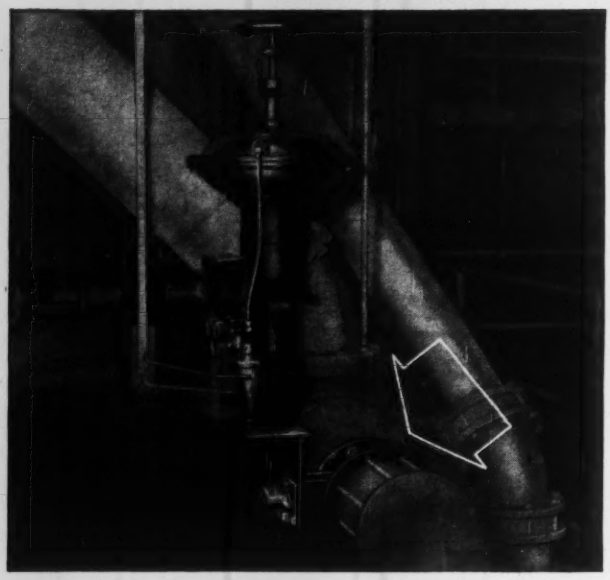
This record speaks for itself. It proves that the Ljungstrom Air Preheater is, indeed, *the most economical heating surface in the modern boiler.*

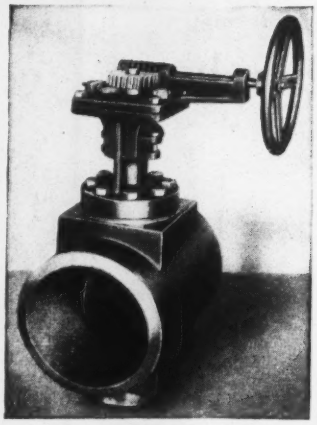
The AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

R-S valveEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •



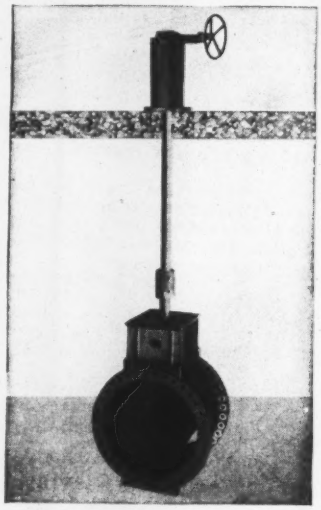


No. 677-A—1500-pound welding-end steel valve for superheated steam service. A. S. M. E. standards with heavy duty handwheel control.

R-S VALVE ADVANTAGES
Under Automatic Control

1. Wide range of throttling from open to closed position. 30 to 1 is standard. Minimum torque required for positioning.
2. Any type of instrument or control actuator can be used depending on preference and conditions. In any application, the R-S Valve usually costs less to purchase, less to install and results in lower pumping costs due to simplicity of design.
3. R-S Valve design offers no pockets to capture sediment, no change of flow-direction to create turbulence. Freedom from turbulence reduces erosion and cavitation and therefore adds to the life of the valve.

R-S Valves are used for regulation, pressure reduction, liquid level control, flow control, shut-off and other functional applications.



No. 864—50-pound valve equipped with rubber seat, extended shaft, thrust bearing, floor stand and heavy duty handwheel control.

Consult your local R-S Valve Engineers, or write direct.

R-S PRODUCTS CORPORATION • 4600 Germantown Ave., Philadelphia 44, Pa.

An S. Morgan Smith Company Subsidiary

REPRESENTATIVES IN PRINCIPAL CITIES

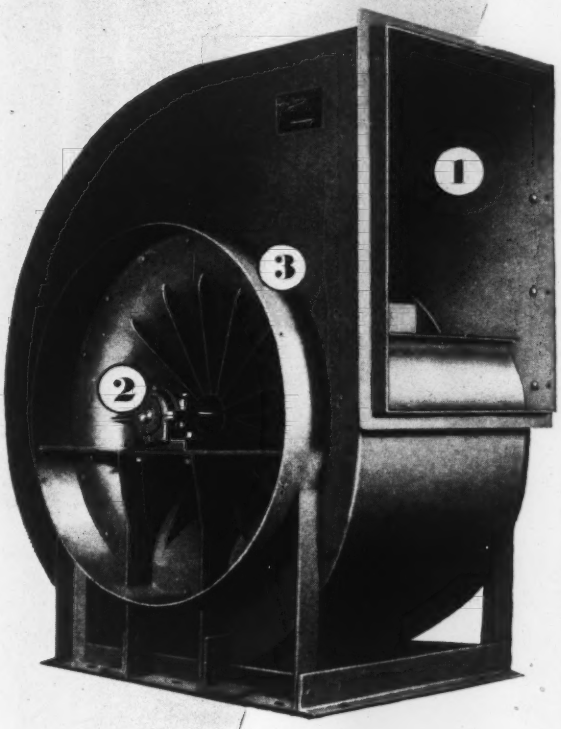
NEW!

"Buffalo" TYPE "BL" Limit-Load Ventilating Fan

REG. U.S. PAT. OFF.

COMPLETE FAN

1. Streamlined housing with outlet designed for most efficient air delivery.
2. Anti-friction or sleeve bearings to suit job requirements.
3. Ample inlet collar for easy connection to ductwork.



In our seventy-six years of fan manufacturing, no fan has been more respected for fine performance than the "Buffalo" Type "LL" Ventilating Fan. This fine performance is now further improved in the new "Buffalo" Type "BL" Limit-Load Fan — designed especially for general ventilation, air conditioning and industrial service.

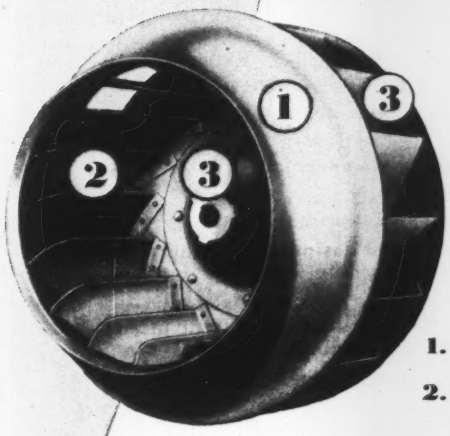
This new fan offers: (1) High efficiency; (2) Minimum noise level, over wide capacity range; (3) Full Limit-Load horsepower characteristic; (4) Stable performance from shut-off to free delivery.

Retaining the husky construction which has characterized "Buffalo" fans for many years, the new Type "BL" has some outstanding quality design features.

The Type "BL" fan will be built in standard sizes and arrangements with rotor diameters from 12¼" to 108¾", to handle from 1,000 to 500,000 cfm.

You will want this superbly-performing new fan with the "Q" Factor* on your next job! Write for new Bulletin F-100, which contains complete engineering details, including performance tables and dimensions.

** The "Q" Factor — The built-in Quality which provides trouble-free satisfaction and long life.*



BUFFALO FORGE COMPANY

148 MORTIMER STREET BUFFALO, NEW YORK

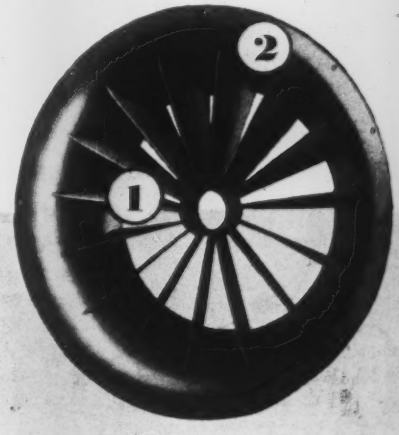
Publishers of "Fan Engineering" Handbook

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

Sales Representatives in all Principal Cities

WHEEL

1. Heavy gauge die-formed shroud full curvature for proper air flow in wheel.
2. Die-formed blades curved and backwardly inclined for stable air flow. Welded and riveted for maximum strength.
3. Solid back plate with extra heavy hub.



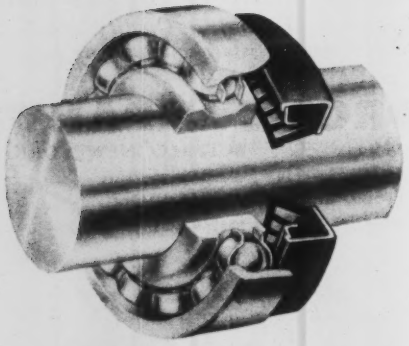
CERTIFIED RATINGS

AUTHORIZED BY N A F M

INLET

1. Furnished as standard, and exclusive with "Buffalo", these stationary inlet vanes reduce turbulence and assure rated air delivery in spite of unfavorable inlet conditions.
2. Die-formed inlet bell matches wheel shroud.

Dependable Bearing Protection for All Service Conditions



Model 53 KLOZURE, with standard sealing element, applied to a shaft to protect the ball bearing.

The true value of any oil seal must be measured by the ability of the sealing element to protect the bearing by keeping the lubricant *in*, dirt and moisture *out*.

For your bearing protection Garlock KLOZURES offer you these important sealing-element advantages:

1. **Synthetic rubber sealing elements** for oil, grease, water, mild acids and alkalies at temperatures up to 300° F.
2. **Silicone rubber sealing elements** for extremes of high and low temperatures.
3. **Teflon sealing elements** for strong acids.
4. **Choice of sealing element designs** with finger spring or garter spring for light, medium or heavy duty service at all speeds.
5. **All sealing elements** accurate and uniform in size, non-porous, tough, durable, non-abrasive and free-running.

Garlock KLOZURE Oil Seals are made in a complete range of sizes and in many models. For complete information call your Garlock representative or write for KLOZURE Catalog No. 10.

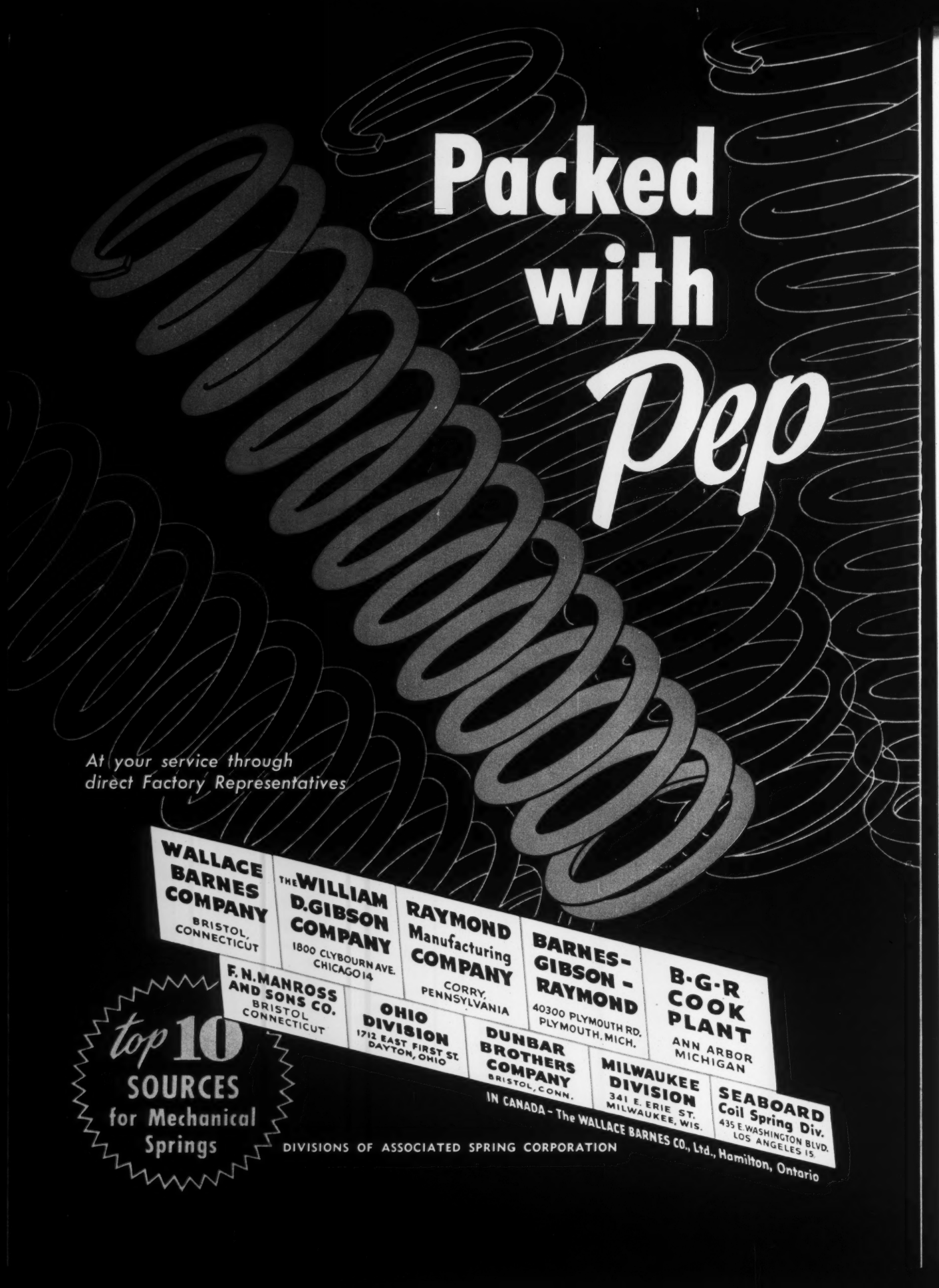
*Registered Trademark

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK
In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.
Branch Offices in Most Principal Cities

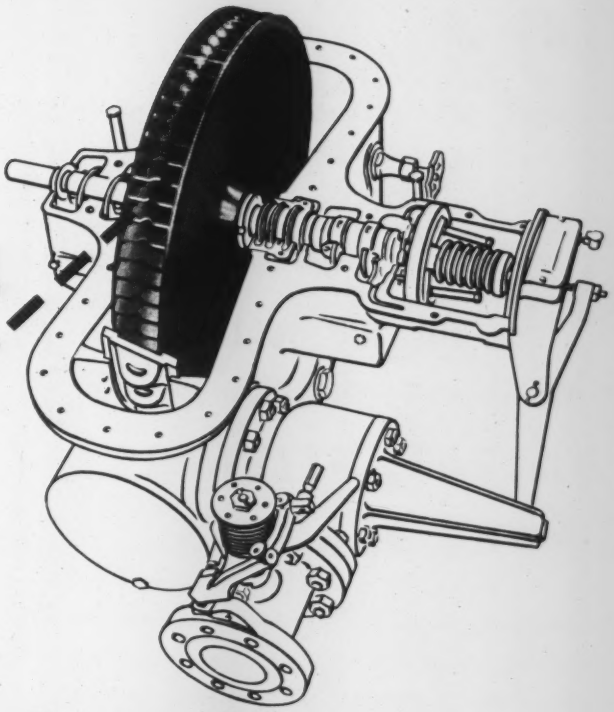
GARLOCK

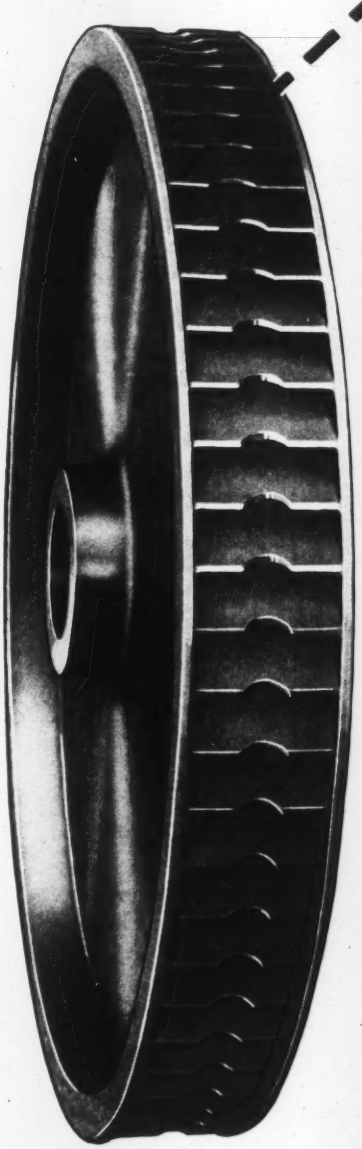
PACKINGS, GASKETS, OIL SEALS,
MECHANICAL SEALS,
RUBBER EXPANSION JOINTS

Alive with
action
Complete Production and Engineering Facilities at each plant —
WALLACE BARNES COMPANY
BRISTOL, CONNECTICUT
THE WILLIAM D. GIBSON COMPANY
1800 CLYBOURN AVE. CHICAGO 14
RAYMOND Manufacturing COMPANY
CORRY, PENNSYLVANIA
BARNES-GIBSON-RAYMOND
40300 PLYMOUTH RD. PLYMOUTH, MICH.
B-G-R COOK PLANT
ANN ARBOR MICHIGAN
F. N. MANROSS AND SONS CO.
BRISTOL CONNECTICUT
OHIO DIVISION
1712 EAST FIRST ST. DAYTON, OHIO
DUNBAR BROTHERS COMPANY
BRISTOL, CONN.
MILWAUKEE DIVISION
341 E. ERIE ST. MILWAUKEE, WIS.
SEABOARD Coil Spring Div.
435 E. WASHINGTON BLVD. LOS ANGELES 15,
top 10 SOURCES for Mechanical Springs
IN CANADA - The WALLACE BARNES CO., Ltd., Hamilton
DIVISIONS OF ASSOCIATED SPRING CORPORATION


Packed with Pep
At your service through direct Factory Representatives
WALLACE BARNES COMPANY
BRISTOL, CONNECTICUT
THE WILLIAM D. GIBSON COMPANY
1800 CLYBOURN AVE. CHICAGO 14
RAYMOND Manufacturing COMPANY
CORRY, PENNSYLVANIA
BARNES-GIBSON-RAYMOND
40300 PLYMOUTH RD. PLYMOUTH, MICH.
B·G·R COOK PLANT
ANN ARBOR MICHIGAN
F. N. MANROSS AND SONS CO.
BRISTOL CONNECTICUT
OHIO DIVISION
1712 EAST FIRST ST. DAYTON, OHIO
DUNBAR BROTHERS COMPANY
BRISTOL, CONN.
MILWAUKEE DIVISION
341 E. ERIE ST. MILWAUKEE, WIS.
SEABOARD Coil Spring Div.
435 E. WASHINGTON BLVD. LOS ANGELES 15
top 10 SOURCES for Mechanical Springs
IN CANADA - The WALLACE BARNES CO., Ltd., Hamilton, Ontario
DIVISIONS OF ASSOCIATED SPRING CORPORATION

TERRY SOLID WHEEL





..."trade mark" of a trouble-free turbine

This is the rotor of a Terry solid-wheel turbine. There are a number of reasons why it has become a symbol for reliable, trouble-free operation.

First, because the wheel is a single forging, in which a series of semi-circular buckets is milled, there are no separate parts to become loose or work out.

Second, because the power-producing action of the steam takes place on the curved surfaces at the back of the buckets, blade wear is of little consequence. Wear does not materially affect horsepower or efficiency.

Third, because the steam enters the buckets in a direction at right angles to the shaft, there is no need for close axial blade clearances. The blades cannot foul. There is a one inch clearance on either side of the wheel. In addition, the blades are double rim protected.

These are only a few of the reasons why the Terry solid wheel has become a "Trade Mark" for trouble-free turbine performance. For complete details, send for a copy of bulletin S-116. No cost or obligation.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1197

24 ACRES *Cover the World*

. . . with TOP QUALITY

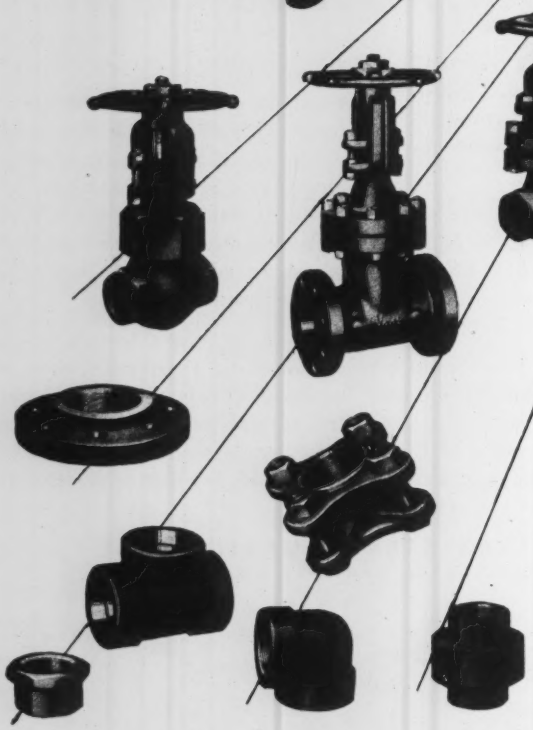
DROP FORGED STEEL

VALVES, FITTINGS and FLANGES

by

Vogt

Air View of
Henry Vogt Machine Co.



This 24 acre Vogt plant supplies the most comprehensive line of top quality *drop forged* steel piping materials anywhere available to industry. That's why they're the choice of leading refineries, power plants, chemical plants, etc., the world around!

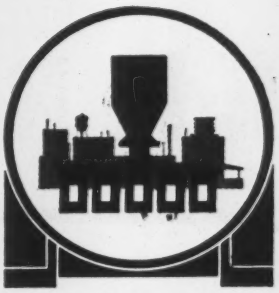
OUR COMPLETE LINE INCLUDES

Flanged, Screwed and Socket Weld End Globe, Gate and Check Valves • Ells, Tees and Crosses • Couplings • Bushings • Plugs • Unions • Flanges and Flange Unions • Welding Heads

HENRY VOGT MACHINE CO. LOUISVILLE 10, KY.

Branch Offices: New York, Philadelphia, Chicago, Cleveland, St. Louis, Dallas, Charleston, W. Va.

Metal Working



Food Processing

Grain Handling

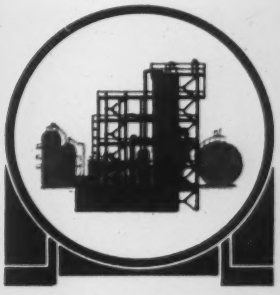
Electric Motors

for every industry

When you need electric motors . . . in any rating, or frame type . . . one or a thousand . . . *always* look for the Fairbanks-Morse Seal. For over 120 years it has stood for the finest in manufacturing integrity to *all* industry.

Fairbanks, Morse & Co., Chicago 5, Illinois.

Chemical Processing



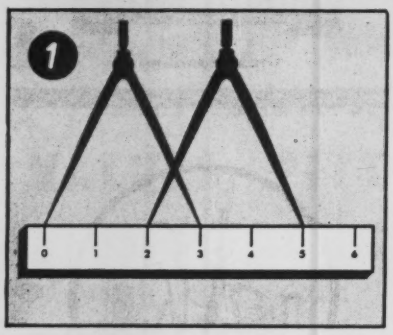
Petroleum Refining

Fairbanks-Morse totally-enclosed, fan cooled motor—in a complete horsepower range.

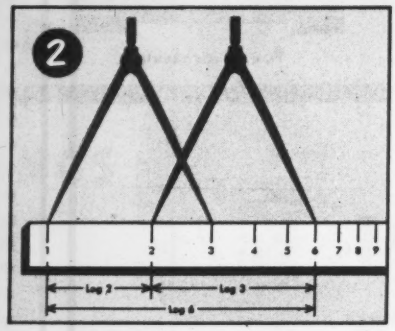
FAIRBANKS-MORSE

a name worth remembering when you want the best

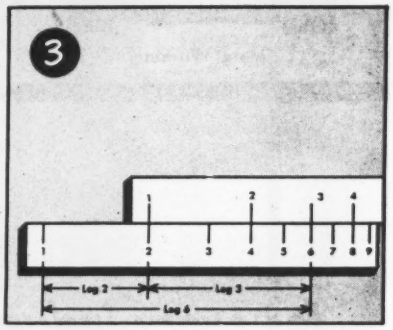
ELECTRIC MOTORS AND GENERATORS • DIESEL LOCOMOTIVES AND ENGINES • RAIL CARS • PUMPS • SCALES • HOME WATER SERVICE EQUIPMENT • FARM MACHINERY • MAGNETOS



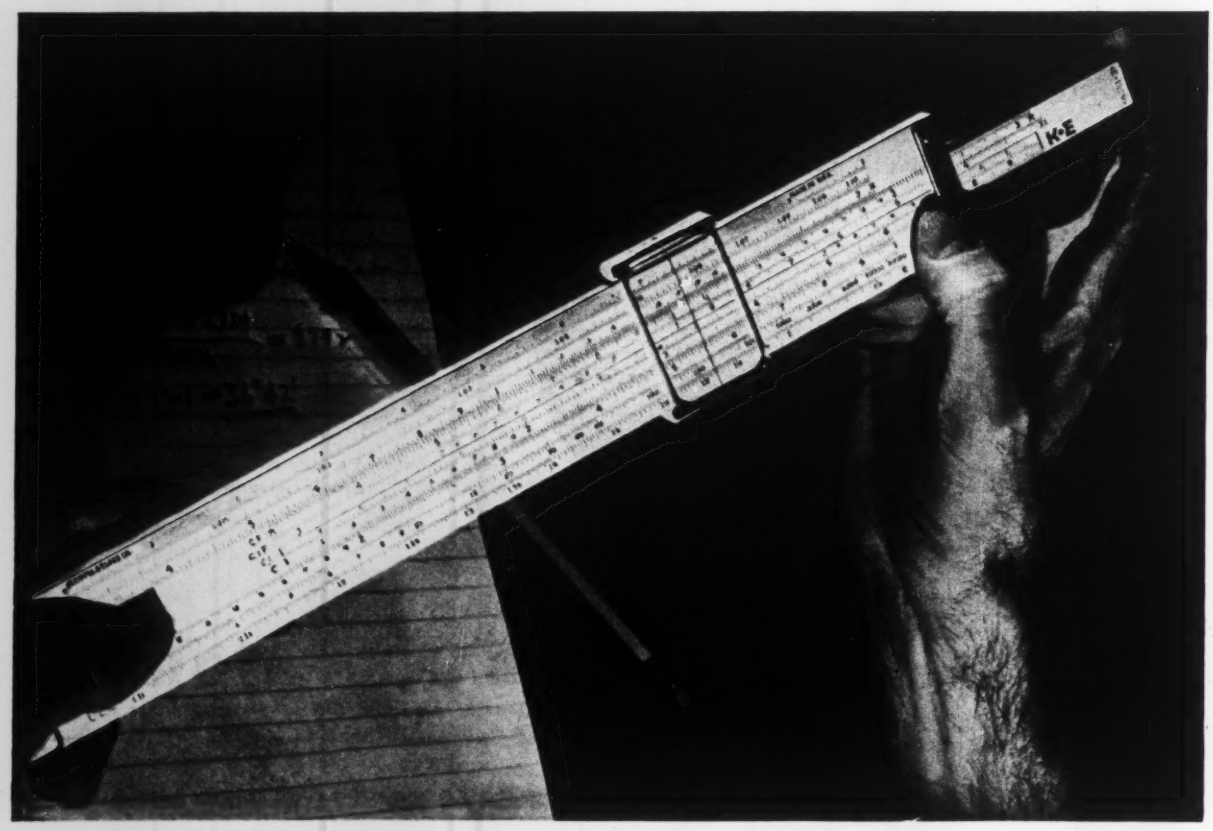
In a mechanical sense, the slide rule merely adds and subtracts quantities. How these simple operations can be performed mechanically may be seen from the illustration above, which shows the addition of 2 and 3 by means of a pair of dividers applied to an ordinary 6-inch rule. Even many electronic calculators work basically on this principle.

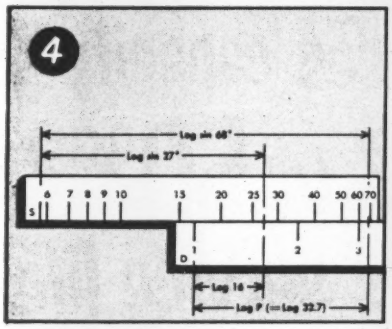


With a different system of calibrations on the scale, if appropriate meanings are assigned to them, more difficult problems may be solved in the same way. An example of this is seen above where a pair of dividers is shown adding 2 and 3 on a logarithmic scale and obtaining the answer 6. Advantage is taken of the fact that the multiplication of numbers may be accomplished by the addition of their logarithms.

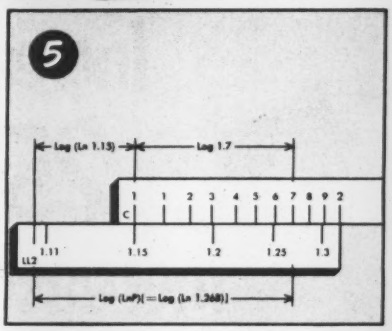


A handier method, which begins to approach the usefulness of a slide rule, is to place two similar logarithmic scales together. Seen above is the simple setting in which 2 is shown being multiplied by 3. Observing the illustration it can be seen that the same setting also multiplies 2 by 2 and 4. Without changing the setting, the device shows the corresponding operations in division.





Problems in plane trigonometry require only appropriate logarithmic scales, calibrated to read in degrees so that operations can be performed on the functions of angles. Two scales of this kind are generally used: one for the sines of angles and the other for tangents. Above is seen a setting for finding $P = \frac{16 \text{ Sin } 68°}{\text{Sin } 27°}$.



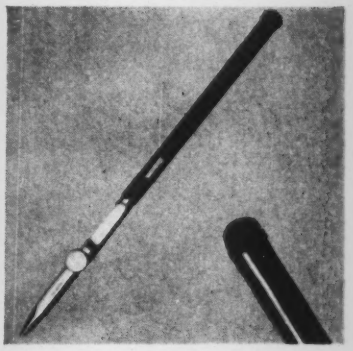
Problems of greater complexity, involving higher powers and roots of numbers, including fractional and negative powers and roots, can also be made as easy as 2 + 3 by means of appropriate logarithmic scales. Known as log log scales, they are calibrated to read in logarithms of logarithms. Above is seen a setting for finding $P = 1.15^{1.7}$.

The slide rule has been called the symbol of the engineer. The symbol that distinguishes the slide rule itself for leadership in design and workmanship is the K&E trade mark or the name KEUFFEL & ESSER CO.

Pioneers in the manufacture of slide rules in America, K&E have always been in the forefront with new ideas and improvements. The most recent example is the slide rule of today, the K&E Log Log Duplex Decitrig*, designed on the fundamental and simple principle of referring all its scales to the basic C-D scales. This enables problems involving arithmetic, trigonometric and exponential functions to be readily solved without reading any but the final answer.

Ask your K&E Distributor or Branch for full information about K&E Slide Rules.

The Right Angle

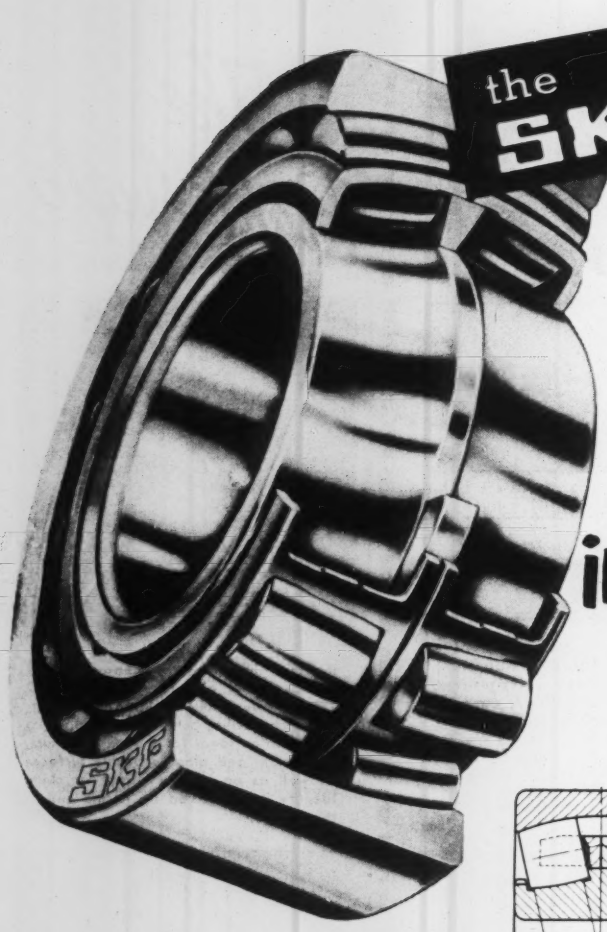


If you'd like l-o-n-g mileage without re-sharpening, get a PARAGON* RED TIP ruling pen. They are tipped with tungsten carbide alloy butt-welded to stainless steel blades. Ideal for use on aluminum, glass cloth and other abrasive surfaces as well as on regular paper or cloth. Identify it by the red tip at the end of the handle.

A good way to make life easier is to give your drawing board a glass-smooth, non-glare working surface with a covering of LAMINENE†. This drawing board backing material is washable, hard enough to minimize pencil scoring, but yielding enough for pencil lines to take well. Comes either white or green, in rolls.

*Trade Mark ®
†Trade Mark

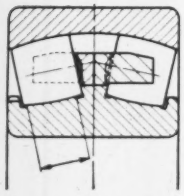
K+E



improvement of internal design of spherical roller bearings

Increases capacity 25% to 50%

increases service life 2 to 3½ times

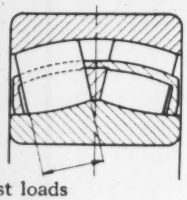


This is the Spherical Roller Bearing design originated by SKF *more than 30 years ago.* The cross-section shows how the integral inner ring flanges, and the undercuts adjacent thereto, limit the effective length of the rollers.

Now, SKF, originator of the Spherical Roller Bearing, has again provided industry with another anti-friction *first.*

This time, it's a revolutionary design advance in Series 222 and 223 bearings providing these advantages:

When designing new equipment, you can obtain the desired life by using smaller or lighter bearings at considerable cost saving. In addition, this forward step in design will carry heavier combinations of radial and thrust loads, or pure thrust loads of greater magnitude. The important self-aligning feature of SKF Spherical Roller Bearings has been preserved, so that considerable misalignment between the shaft and housing has no ill effect whatever on bearing capacity or life.



Here is the latest SKF improvement, a *revolutionary advance in design.* Effective roller guiding is accomplished by means of a separate ring. The need for undercuts is eliminated! This type of guide ring permits the rollers to take the position which their contact with the rings dictates. This assures uniform load distribution over the entire length of the longer rollers at all times. *Result*—greatly increased capacity and life.

During more than 4 years, thousands of installations have been made in railroad journals, vibrating screens, steel mill machinery and numerous other fields. In all cases performance has been outstanding.

SKF Sales Engineers in our District Offices throughout the country will assist you in making use of the important advantages of the improved internal design of SKF Spherical Roller Bearings. **SKF INDUSTRIES, INC.,** Dept. 616, PHILADELPHIA 32, PA.
— *manufacturers of* SKF *and* HESS-BRIGHT *bearings.*

7424

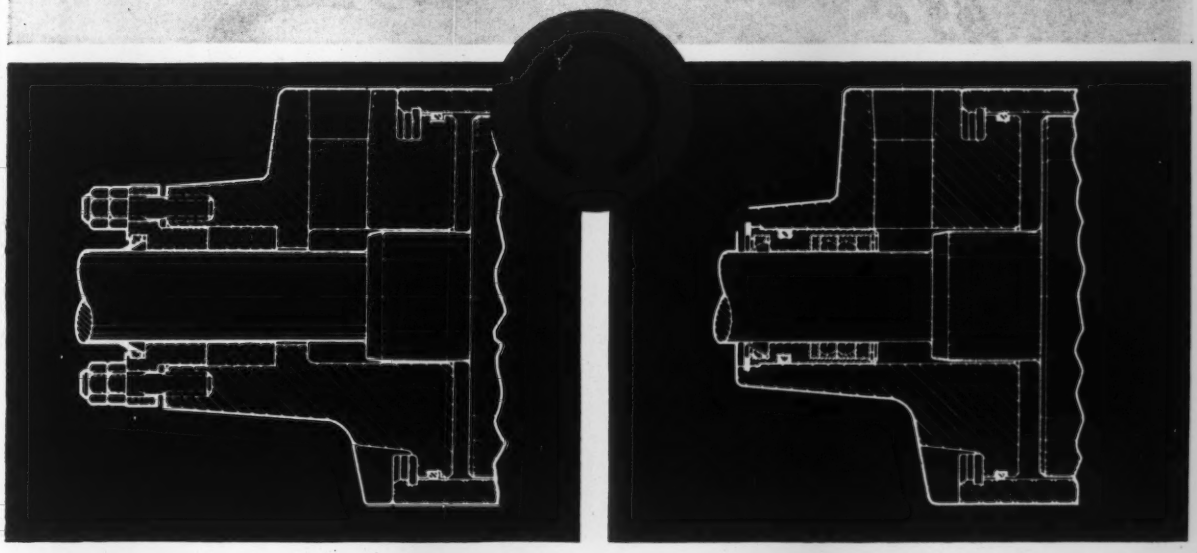
SKF®

BALL AND ROLLER BEARINGS

This 12-page booklet gives you additional facts—sizes available—added capacity, size by size—increased life you can expect for each size—dimensional tabulations—and load and speed data. Write now for your free copy of Booklet No. 365-2.

© 1953, SKF INDUSTRIES, INC.,

Waldes Truarc Ring Saves $2.84 Per Unit, Cuts Labor-Time and Materials in Hydraulic Packing Unit



OLD STYLE stuffing box required skilled worker to install packing rings one at a time, then adjust packing glands by trial and error. Disassembly was equally difficult, time-consuming and costly.

NEW Monopak Cartridge is smaller, lighter, streamlined and installed with one Truarc Retaining Ring. Disassembly and reassembly with new cartridge takes unskilled worker just 1 minute.

Hydraulic Accessories Company of Van Dyke, Michigan, uses a single Waldes Truarc Inverted Ring (internal series 5008) to hold Monopak Cartridge in cylinder head.

New design eliminates costly machining and saves 2⅛ lbs. of material. Re-design with Waldes Truarc Retaining Ring reduces stuffing box diameter from 3½" to 2⅞", and reduces length from 5⅞" to 4⅜". Allows savings in assembly, adjusting and testing.

NEW DESIGN USING WALDES TRUARC RING PERMITTED THESE SAVINGS PER UNIT

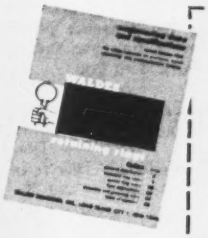
MACHINE TIME SAVED:	
Chucking, facing and boring	$ .72
Drilling and tapping 3 holes	.18
Drilling and counterboring 3 holes	.12
Assembling, adjusting, testing	.90
MATERIAL SAVED:	
1⅛ lbs. cast iron	.30
⅛ lb. bronze	.23
3 studs	.36
3 nuts	.03
TOTAL	**$2.84**

Waldes Truarc Retaining Rings are precision-engineered . . . quick and easy to assemble and disassemble. Always circular to give a never-failing grip. They can be used over and over again. There's a Waldes Truarc Ring to answer every fastening problem.

Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

For precision internal grooving and undercutting . . . Waldes Truarc Grooving Tool.

SEND FOR NEW CATALOG



WALDES

TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,848; 2,455,165; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,509,081 AND OTHER PATENTS PENDING

Waldes Kohinoor, Inc., 47-16 Austel Place, L.I.C. 1, N.Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

(Please print) ME 105

Name .....

Title .....

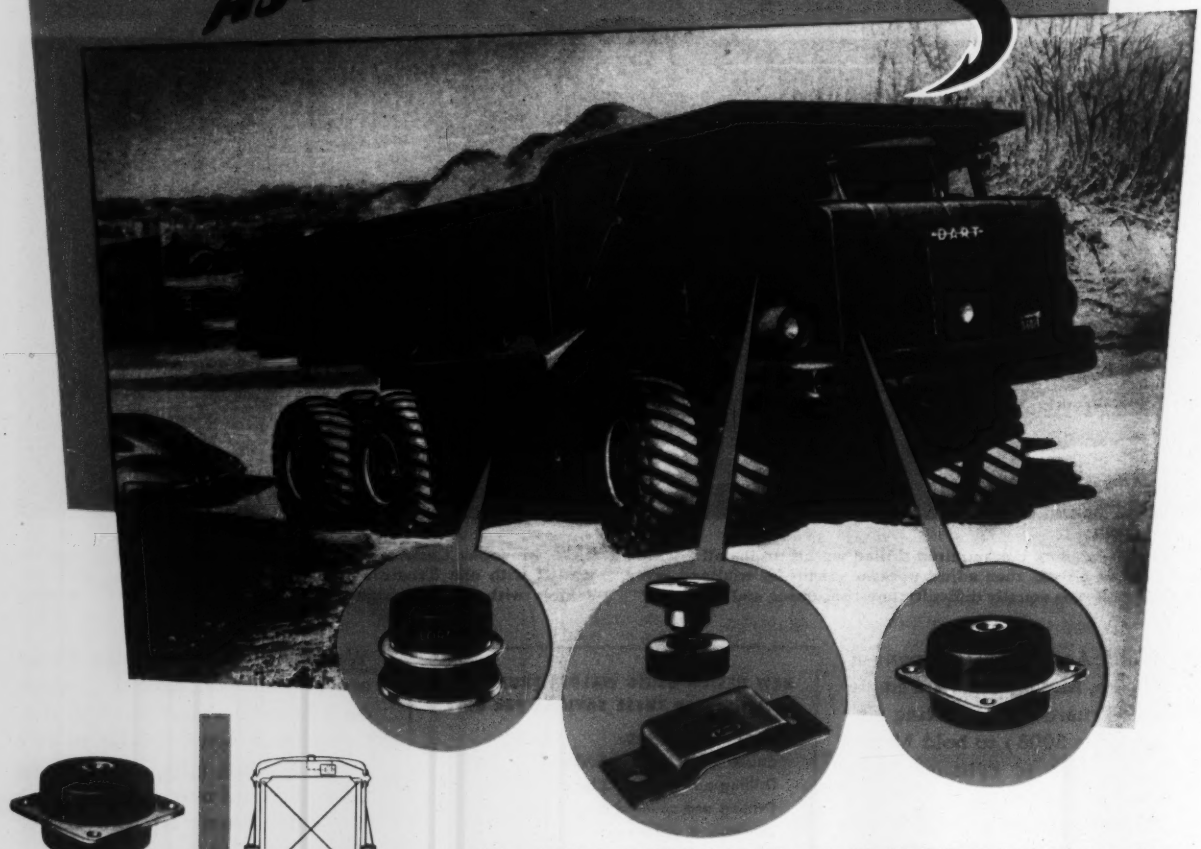
Company .....

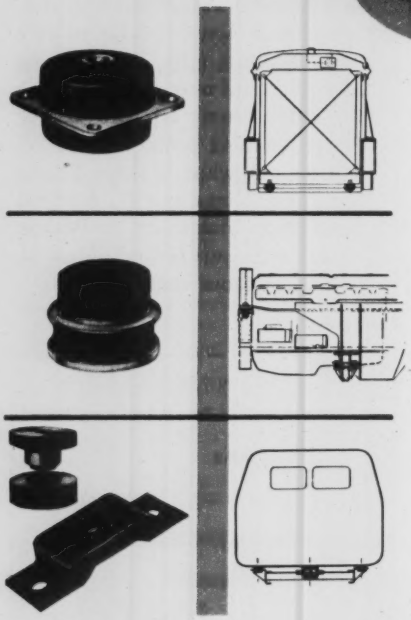
Business Address .....

City ..... Zone ..... State .....

★

LORD Bonded-Rubber Mountings... As RUGGED AS THIS





The world's largest "off-the-road" truck, Model 60 Dart, hauls 60 tons of copper ore from the huge shovels in the pits of The Bagdad Copper Mines of Bagdad, Arizona to the mine rim over tortuous, twisting, climbing roadways impossible for any other means of transportation. Contributing to the desired performance of this mammoth vehicle, Lord Bonded-Rubber Mountings cushion the twin radiators against vibration and shock, thus protecting the vital cooling system and reducing maintenance costs.

The two 350 hp. diesel engines and transmission assemblies are protected from the shocks of rough going by Lord Mountings . . . these same mountings provide a barrier between damaging engine vibration and the truck itself. To complete the job Lord Mountings protect the cab.

As rugged as the products they protect, Lord Bonded-Rubber Parts are used every day to improve the performance of industrial products large and small . . . Let us work with you.

BURBANK, CALIFORNIA 233 South Third Street
DALLAS, TEXAS 413 Fidelity Union Life Building
PHILADELPHIA 7, PENNSYLVANIA 725 Widener Building
DAYTON 2, OHIO 410 West First Street
DETROIT 2, MICHIGAN 311 Curtis Building
NEW YORK 16, NEW YORK 280 Madison Avenue
CHICAGO 11, ILLINOIS 520 N. Michigan Ave.
CLEVELAND 15, OHIO Room 811 Hanna Building

LORD MANUFACTURING COMPANY • ERIE, PA.

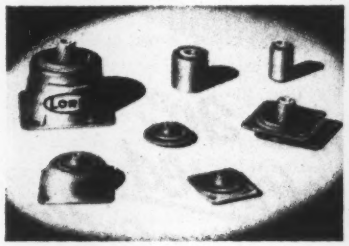
LORD BONDED RUBBER

Headquarters for **VIBRATION CONTROL**

Lord Vibration Control Mountings . . . The Most Effective Protection For Electronic Equipment

In the rapidly advancing field of electronics, the control of destructive vibration and isolation of damaging shock are prime factors in the consideration of design engineers. Lord, Headquarters for Vibration Control, is constantly working with electronics engineers to improve the methods for protecting sensitive mechanisms.

For instance, Varo Static Converters which change alternating to direct current for aircraft with less than 1% voltage ripple are protected against shock and vibration by Lord Mountings. High fidelity Audio frequency electronic equipment such as Collins Radio Company manufactures is protected from vibration and shock through the use of Lord Mountings. The 212A-1 Broadcast Station Speech Input Console by Collins requires 28 Lord square Plate Form Mountings to protect each amplifier stage individually. This prevents mechanical interaction between stages and lessens acoustical feed-back effects.



Again the Agnew Spark Plug Welder by Agnew Electric Company uses Lord Mountings to support the electronic weld timers to prolong the useful service life of Mercury Vapor Tubes.

Lord Mountings, which you see illustrated in the accompanying advertisement, are used in a wide diversity of applications to protect electronic equipment and sensitive instruments. Business machines and such sensitive mechanisms, the accuracy of which must be perfect, are improved in operation and protected from damaging vibration and shock by Lord Mountings.

The Lord Manufacturing Company, Erie, Pa., offers a vast reservoir of recorded experience in the solution of vibration and shock problems. Your request for help on your own problem is welcomed.

SENSITIVE electronic equipment for airline transmitting and receiving must give continuously accurate results. For instance, note this "inside" view of the Collins Transceiver, mounted on Lord Temproof Mountings which isolate it from vibration and shock. Lord Temproof Mountings function efficiently throughout operational ranges of temperature from —80° to +250°F. The Collins Transceiver with automatically tuned elements for maximum flexibility and high power output delivers maximum performance in any weather, completely protected from vibration, shock and excessive equipment motion at resonant frequencies by Lord Temproof Mountings.

May we give you further details on this Lord application or help you solve your specific mounting requirement?

BURBANK, CALIFORNIA 233 South Third Street
DALLAS, TEXAS 413 Fidelity Union Life Building
PHILADELPHIA 7, PENNSYLVANIA 725 Widener Building
DAYTON 2, OHIO 410 West First Street
DETROIT 2, MICHIGAN 311 Curtis Building
NEW YORK 16, NEW YORK 280 Madison Avenue
CHICAGO 11, ILLINOIS 520 N. Michigan Ave.
CLEVELAND 15, OHIO Room 811 Hanna Building

LORD MANUFACTURING COMPANY • ERIE, PA.

LORD BONDED RUBBER

Headquarters for VIBRATION CONTROL

Why accept this?... when you actually want this?...

CARMET blanks are preformed to your order!

GET THE NEW
CARMET CATALOG

Just out . . . 32 well-illustrated pages, containing data on all Carmet grades, and on Carmet blanks, tools, die sections, punches, draw die inserts, etc.; also special preforming to order. ● *Write for your copy.*

ADDRESS DEPT. ME-46

Above are shown two carbide metal rolls of identical composition. The one at the left cost the user about nine times as much as the one at the right. That differential was due solely to grinding vs. non-grinding. The plain face needed serrating, whereas the ready-toothed face needed nothing.

In many uses where tolerances are not too critical, CARMET blanks *preformed* to your specifications are ready for service without additional costly grinding. On jobs where finish grinding is necessary, the quality of Carmet's preforming holds grinding stock to a minimum.

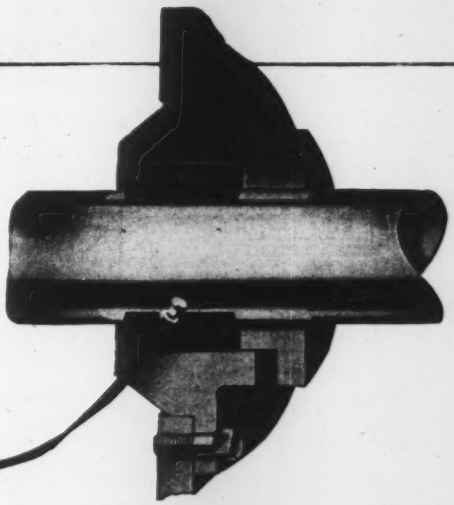
Hundreds of special shapes can be preformed in Carmet. For practical suggestions that fit your needs, call or write your nearest A-L representative. ● *Allegheny Ludlum Steel Corporation, Carmet Division, Wanda & Jarvis Avenues, Detroit 20, Michigan.*

For complete **MODERN** Tooling, call
Allegheny Ludlum
W&D 4048

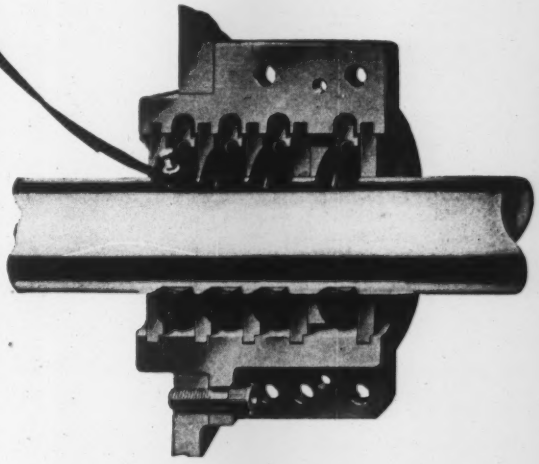
AL
FINE TOOL STEELS
SINCE 1854

COPPUS TURBINES

offer you a choice of packing rings



STANDARD METALLIC RING PACKING — Made of high grade asbestos cores encased in specially treated lubricated aluminum foil. Recommended as a low-friction, long-service packing for steam temperatures up to 850 F and back pressures up to 50 lb. Adjustable packing glands keep leakage at minimum. Easy access to packing rings.



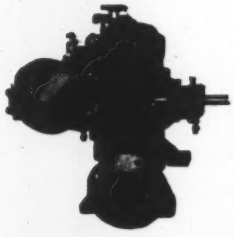
OPTIONAL CARBON RING PACKING — Consists of three carbon packing rings on the pressure side and one beyond the leak-off section. Each ring has three segments held together by a stainless steel garter spring. For back pressures up to 75 lb. Standard for vacuum or gas operation, or when leak-off is desired.

Heavy chrome plating on shaft at stuffing box is common to both types of Coppus packing.

Coppus Turbines ranging from 150 hp down to fractional in 6 frame sizes

FIT TURBINE COSTS TO HORSEPOWER NEEDS

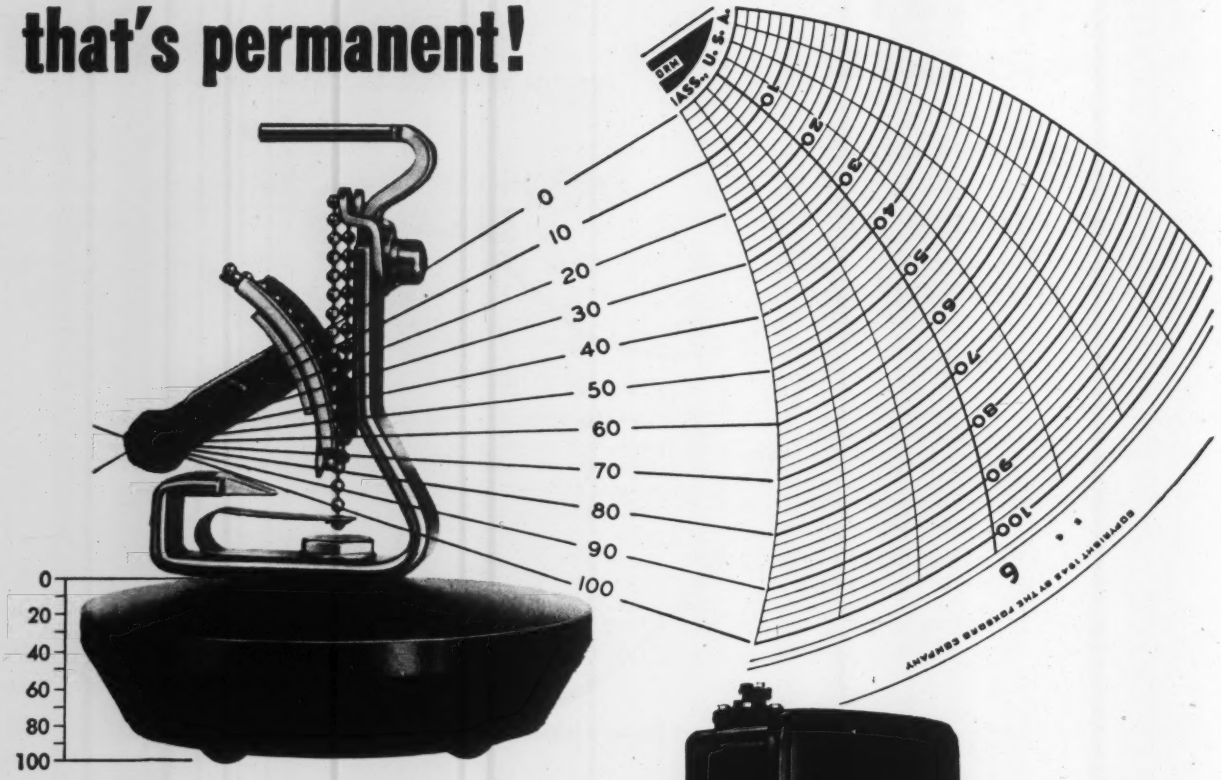
When you buy turbines rated close to your exact horsepower needs, you save plenty of money. That's because turbines are generally priced in proportion to their size. The wide range of sizes of Coppus Turbines promises purchasing economy for you from the 150 hp size down to the smallest. As for operating and maintenance economies, you get them, too, from such other features as: greater number of manually operated valves for individual control of steam nozzles; replaceable cartridge-type bearing housings and others. For complete details . . .



WRITE FOR BULLETIN 135
COPPUS ENGINEERING CORPORATION
370 Park Avenue
Worcester 2, Mass.
Sales offices in
THOMAS' REGISTER

COPPUS "BLUE RIBBON" TURBINES

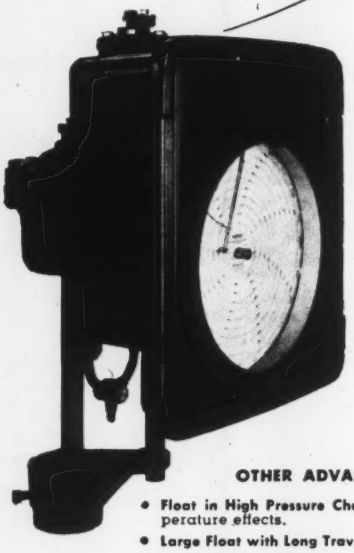
Full-scale meter accuracy that's permanent!



Exclusive Segmental Lever Design Gives Linear Transmission from Float to Pen Point . . . No Angularity Errors

A basic-design feature of Foxboro Flow Meters insures permanent calibration at all readings on the scale, by eliminating angularity errors and lost motion. The exclusive Segmental Lever drive transmits vertical motion of the float to the pen in positive, linear relationship. Its stainless steel ball chain runs free and true, regardless of meter alignment.

This is only one of several better-engineered features that have made Foxboro Flow Meters the unqualified choice of industries wherever dependability and "cash-register" accuracy of metering are important. Available in rectangular and circular case models. Write for complete story in Bulletin 460. **The Foxboro Company, 9610 Neponset Avenue, Foxboro, Massachusetts, U.S.A.**



OTHER ADVANCED FEATURES

- **Float in High Pressure Chamber** minimizes ambient temperature effects.
- **Large Float with Long Travel** gives high-power pen drive.
- **Sure-Seal Check Floats** with positive-seating ball plugs submerged in mercury prevent sticking, leaking, corrosion. Will not blow mercury.
- **Pressure Seal Bearing** is friction-free, completely leak-proof, interchangeable. No stuffing box. No lubricator.
- **Self-aligning, Union-Coupled U-Bend** — No gaskets. Fully-adjustable plug gives calibrated damping, directed drain.

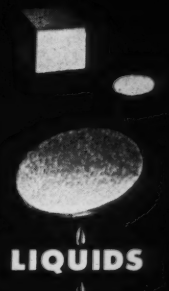
OVER 100,000 FOXBORO FLOW METERS WITH SEGMENTAL LEVER ARE IN USE TODAY

FOXBORO REG. U.S. PAT. OFF. — First in FLOW METERS

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

OILITE
Permanent METAL FILTERS

Oilite PERMANENT FILTERS Provide:



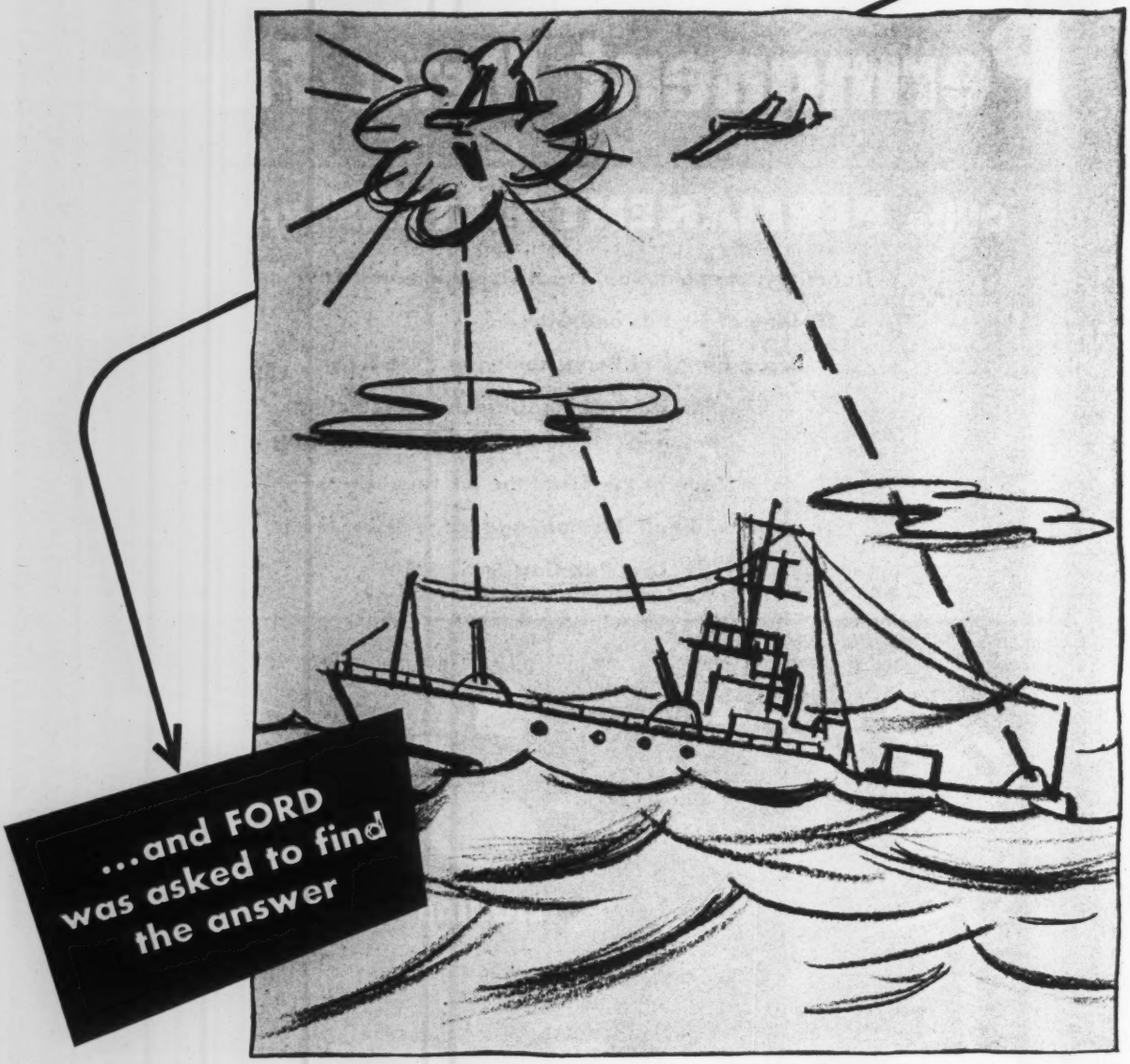
CHRYSLER CORPORATION
Amplex Division, Dept. C
DETROIT 31, MICHIGAN

FIELD ENGINEERS, DEPOTS AND DEALERS THROUGHOUT UNITED STATES AND CANADA

Oilite Products Include: Bearings, Finished Machine Parts, Cored and Solid Bars, Permanent Filters and Special Units

6435

TO HIT TARGET
from unstable decks of ship



A rolling, pitching ship... under attack from speedy, diving aircraft... counts on its anti-aircraft guns for protection... these guns must be able to stay on the target regardless of sea conditions. That's why the Ford Instrument Company was called on to design and build a control system that tracks and holds the target range with deadly accuracy.

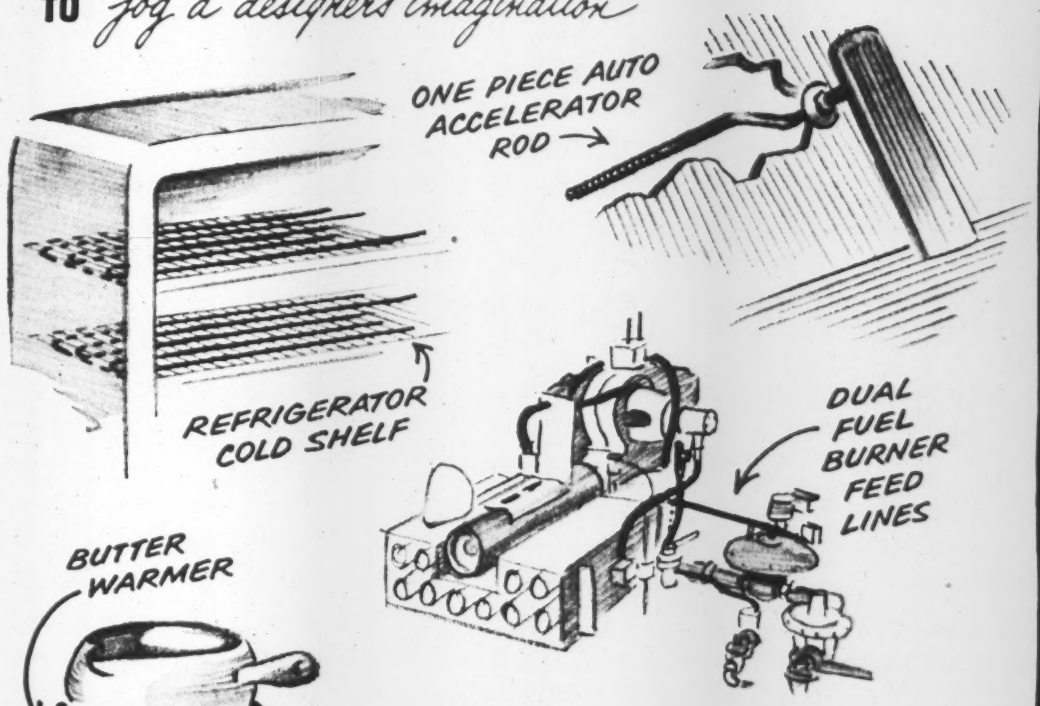
This is typical of the problems that Ford has solved since 1915. For from the vast engineering and production facilities of the Ford Instrument Company, come the mechanical, hydraulic, electro-mechanical, magnetic and electronic instruments that bring us our "tomorrows" today. Control problems of both Industry and the Military are Ford specialties.

You can see why a job with Ford Instrument offers young engineers a challenge. If you can qualify, there may be a spot for you in automatic control development at Ford. Write for brochure about products or job opportunities. State your preference.

FORD

FORD INSTRUMENT COMPANY
DIVISION OF THE SPERRY CORPORATION
31-10 Thomson Avenue, Long Island City 1, N. Y.

FROM *the Bundy Sketchbook*
TO *jog a designer's imagination*



REMARKS Give your ideas a cost-saving twist -- with Bundyweld Tubing. The very standard of dependability, it's helped beat many design, fabrication problems. Add: Bundy's unmatched fabricating, specialized engineering.

WRITE today for Bundyweld catalog or for help in developing your tubing application ideas.

BUNDY TUBING COMPANY, DETROIT 14, MICH.

Bundyweld Tubing

® DOUBLE-WALLED FROM A SINGLE STRIP

Leakproof
High thermal conductivity
High bursting point
High endurance limit
Extra-strong
Shock-resistant
Ductile

Lightweight
Machines easily
Takes plastic coating
Scale-free
Bright and clean
No inside bead
Uniform I.D., O.D.

WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . . continuously rolled twice around laterally into a tube of uniform thickness, and passed through a furnace. Copper coating fuses with steel. Result . . . Bundyweld, double-walled and brazed through 360° of wall contact.

← **NOTE** the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

Bundy Tubing Distributors and Representatives: ***Cambridge 42, Mass.:*** Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Philadelphia 3, Penn.:*** Rutan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave. South ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 181 Fleet St., E. • **Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.**

A blind rivet that may open your eyes

There may be a message for you in these pictures, even if you don't use rivets.

For maybe you have a product that isn't performing the way you want it to. And maybe your problem is to find the right metal.

The makers of "pop" rivets had just such a problem.

Here they'd come up with a wonderful idea for a blind fastening. The "pop" rivet lets you rivet tightly in blind corners and other confined places where you can only get to work on one side. And it's easy to use and does the job inexpensively. Still, the metal used wasn't quite right for every job . . .

First, they needed a metal that is strong enough to make a tight joint, even in thin gauge sheet metal. Yet the metal had to be ductile enough to form a tight-holding head when riveted. And it had to be able to resist corrosion by most acids, alkalies and many other corrosives.

After trying other metals, they found Monel® provided their answer. And the characteristics and the economy of Monel "pop" rivets make them a possible replacement for many non-blind fastenings as well, wherever a hollow Monel rivet can be used for N.P.A.-approved applications.

Perhaps this metal problem of the rivet makers brings one of your own to mind. And perhaps your solution, too, lies in Monel, or another metal in the Inco Nickel Alloy family. The quickest, easiest way to find out is to write us. All our problem-solving services are yours for the asking. The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

"Pop" Rivets, long known as "Tucker Blind Rivets" in Great Britain, are now being produced in this country by J. C. RHODES & COMPANY, branch of UNITED SHOE MACHINERY CORPORATION, New Bedford, Mass.

Monel "Pop" Rivet as it looks from side opposite the riveter. Rivet is ready to be set, joining these two strips.
steel head of mandrel
hollow Monel "pop" rivet
Rivet head begins to form (note ductility) as mandrel is drawn back through rivet by riveting tool.
Head is clinched down tight on work until steel mandrel breaks off inside rivet at 1800 pounds pull.
(Actual diameter of rivet 3 16-inch - - magnified about 3 times

Inco Nickel Alloys

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL • "S"® MONEL • INCONEL® • INCONEL "X"® • INCONEL "W"® • INCOLOY® • NIMONIC® ALLOYS • NICKEL • LOW CARBON NICKEL • DURANICKEL®

MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 75 NUMBER 10

Contents for October, 1953

DESIGN CONSIDERATIONS ASSOCIATED WITH LARGE ALUMINUM FORGINGS — *C. W. Andrews* — 777

ORGANIZATION FOR PRODUCTION ENGINEERING — *R. H. McCarthy* — 785

HIGH-ALTITUDE AND SPEED PROPULSION WIND TUNNEL — *F. L. Wattendorf, J. Noyes, and A. I. Ponomareff* — 789

MACHINING OF HIGH-TENSILE-STRENGTH STEEL — *F. M. Rayburn* — 794

EXPLORERS AND CREATORS — *L. A. DuBridge* — 796

ENGINEERING MODE OF ANALYSIS — *G. A. Hawkins and L. M. K. Boelter* — 799

BEARINGS, LUBRICANTS, AND LUBRICATION — 801

EDITORIAL 773
BRIEFING THE RECORD 809
ASME TECHNICAL DIGEST 818
CONTENTS OF ASME TRANSACTIONS . . 830
COMMENTS ON PAPERS 831
REVIEWS OF BOOKS 832
ASME BOILER CODE 835
ASME NEWS 836
ENGINEERING SOCIETIES PERSONNEL SERVICE . . 856

CLASSIFIED ADVERTISEMENTS . . . 149
CONSULTANTS 154
ADVERTISERS 156

OFFICERS OF THE SOCIETY:

FREDERICK S. BLACKALL, JR., *President*

J. L. KOPF, *Treasurer* — C. E. DAVIES, *Secretary*

E. J. KATES, *Assistant Treasurer*

PUBLICATIONS STAFF:

GEORGE A. STETSON, *Editor* — S. A. TUCKER, *Publications Mgr.*

K. W. CLENDINNING, *Managing Editor* — J. M. CLARK, *Business Mgr.*

M. MARTY, *Asst. Business Mgr.*

J. J. JAKLITSCH, JR., *Technical Editor* — E. S. NEWMAN, *News Editor*

PUBLICATIONS COMMITTEE:

GEORGE R. RICH, *Chairman*

PAUL T. NORTON, JR. — COLIN CARMICHAEL

OTTO DE LORENZI — W. E. REASER

MORRIS GERR, JOSEPH SCHMERLER } *Junior Advisory Members*

REGIONAL ADVISORY BOARD OF THE PUBLICATIONS COMMITTEE:

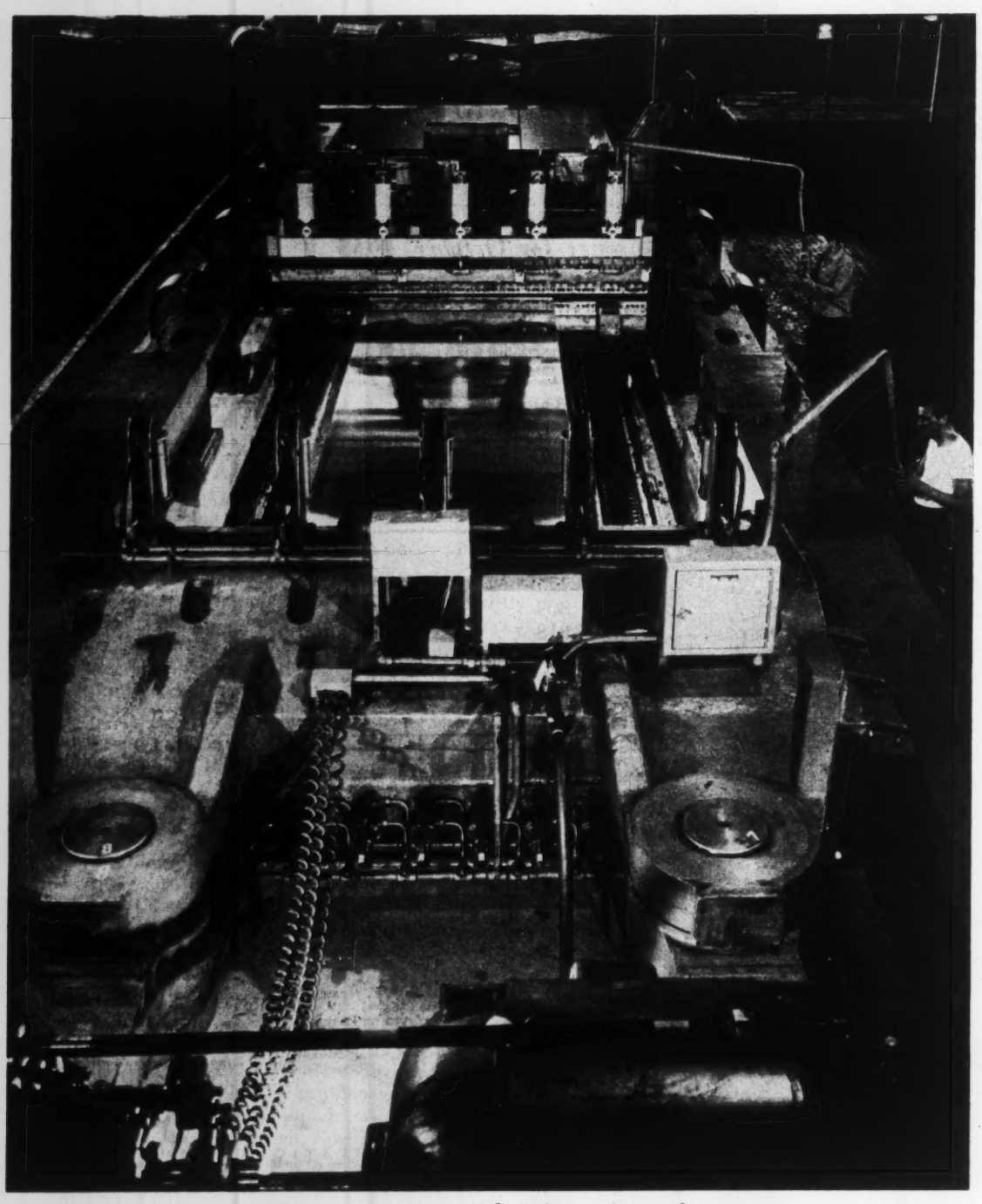
KERR ATKINSON—I — WILLIAM N. RICHARDS—III — HENDLEY BLACKMON—V — RAYMOND G. ROSHONG—VII

JOHN DE S. COUTINHO—II — FRANCIS C. SMITH—IV — CHESTER R. EARLE—VI — VENTON L. DOUGHTIE—VIII

Published monthly by The American Society of Mechanical Engineers. Publication office at 20th and Northampton Streets, Easton, Pa. Editorial and Advertising departments at the headquarters of the Society, 29 West Thirty-Ninth Street, New York 18, N. Y. Cable address, "Dynamic," New York. Price to members and affiliates one year $3.50, single copy 50 cents, to nonmembers one year $7.00, single copy 75 cents. Extra postage to countries not in the Pan-American Union, $1.50; to Canada, 75 cents. Changes of address must be received at Society headquarters four weeks before they are to be effective on the mailing list. Please send old as well as new address. . . . By-Law: The Society shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B13, Par. 4). . . . Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879. . . . Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on January 17, 1921 . . .

Copyrighted, 1953, by The American Society of Mechanical Engineers. Member of the Audit Bureau of Circulations. Reprints from this publication may be made on condition that full credit be given MECHANICAL ENGINEERING and the author and that date of publication be stated.

MECHANICAL ENGINEERING is indexed by the Engineering Index, Inc.



New 5,000,000-Lb Plate Stretcher

(Machine shown is stretching plate of 75S alloy, measuring 6 ft in width and 1 1/2 in. thickness, representing a cross-sectional area of 108 sq in. The stretcher is in operation at the Trentwood, Wash., rolling mill of the Kaiser Aluminum and Chemical Corporation. Further details can be found on page 817 of this issue.)

VOLUME 75
No. 10

MECHANICAL ENGINEERING

OCTOBER
1953

GEORGE A. STETSON, *Editor*

Arthur M. Greene, Jr.

THE sudden death, on Sept. 2, 1953, of Arthur M. Greene, Jr., dean-emeritus of the School of Engineering, Princeton University, and Honorary Member, The American Society of Mechanical Engineers, brought to a close a long career of service to the engineering and teaching professions. Dean Greene, who was in his eighty-second year, suffered a heart attack while swimming at Madison, Conn. To the end of his life he retained an alert and active mind, an extraordinarily vital energy, and a cheerful, optimistic enthusiasm which endeared him to students, colleagues, and friends alike.

There is something in the atmosphere and opportunities of the teaching profession which develops not only the intellectual but the human qualities of the men who enter it. As in all professions, relatively few persons attain real distinction. But in every age, in every land, in every field of learning, certain teachers have towered above their fellows and have left their imprint on the students who filled their classrooms. They give themselves to the enrichment and instruction of younger men and thereby enrich and ennoble their own lives. Their material rewards are meager, but their satisfactions are beyond appraisal. They have that inner vision which recognizes in the youths who come under their instruction the potentialities of greatness others may not see. They ask little more than to cherish the belief that they may have some part in the achievements of their students in later life and the hope vicariously to find in them the fulfillment of their own youthful dreams. Dean Greene was such a teacher.

* * *

Arthur M. Greene, Jr., was born on Feb. 4, 1872. His granduncle, Francis Stillman Greene, had been a professor of engineering at Brown University and his great-great grandfather a teacher also. His father, Major Arthur Maurice Greene, was a builder in Philadelphia, that city which was the cradle of American liberty and of the mechanic arts and manufacture; Benjamin Franklin's city where the great Institute which bears his name once housed the U. S. Patent Office and spent on the investigation of boiler explosions the first Congressional appropriation ever to be made for research; where the Centennial Exposition of 1876 gave the people of the United States a vision of the industrial potential that lay within their grasp; where Elihu Thompson, the school teacher, was experimenting with electricity; where the shops of Sellers, Baldwin, and I. P. Morris, at which the young Greene worked in the summertime, were building machine tools, locomotives, and hydraulic machinery; where James Mapes Dodge, a former ASME president, who was a sponsor for Greene when he applied for member status in the Society, put into practice the revolutionary principles of scientific management developed by another ASME president, Frederick Winslow Taylor. It was a city of schools, colleges, and universities; the Philadelphia Manual Training School, from which Greene was graduated in 1889, the University of Pennsylvania, which conferred on him the degrees of BS in 1893 and ME in 1894 and the honorary degree of ScD in 1917; and Drexel Institute, where he served as instructor in drawing, graphics, and kinematics in 1894.

It is said of Dean Greene that, even as a high-school student, he aspired to teach until he was eighty. That ambition he not only realized but exceeded. As background for this long career he constantly added industrial experience whenever opportunity afforded it, such as summer work in the drawing offices of the Peoples Traction Company and Union Traction Company. From 1890 to 1892 he was instructor in shopwork at the Hamilton School for boys, and, from 1891 to 1894, he was in charge of the apprentice school of the Franklin Sugar Refinery. While still an undergraduate at the University of Pennsylvania, he served for six months as an instructor in mechanics of materials; and, after the year of teaching at Drexel, he returned, in the fall of 1895, to his alma mater as instructor in mechanical engineering, a position he held until he was called to the University of Missouri in 1902. At the University of Pennsylvania he became the associate of his former professor, Henry Wilson Spangler, one of that remarkable group of young men who came out of the U. S. Naval Academy in the closing quarter of the nineteenth century to enrich the faculties of engineering schools throughout the nation, such men as Cooley, Hollis, and Durand. Under the direction of Spangler, the young Greene planned the mechanical-engineering laboratory. Professor Spangler's signature appears on Greene's original application for junior membership in ASME in 1895; and it was with him and S. M. Marshall as coauthors that in 1902 Greene wrote his first book, "Elements of Steam Engineering." During this period also he served as mechanical engineer of the National Export Exposition which was held in 1899.

* * *

At the University of Missouri Greene was professor of mechanical engineering. During the first year in this post, he rearranged the curriculum and equipped the new

mechanical-engineering laboratory. He was in charge of the power plant and maintenance service of the University and acted as consulting engineer for many state activities. Later, in 1940, the University conferred on him the honorary degree of LLD.

It was at Missouri that he met, and married on June 12, 1906, Mary Elizabeth Lewis, a professor of English in the Women's College at the University. Mrs. Greene had taught at Coates College, Terre Haute, Ind., at the University of North Dakota, and at Honolulu before going to Missouri in 1903, and for years she was active in the Association of University Women. The Transactions of ASME record that 261 members of the Society and their ladies boarded the "great steam yacht" *Victoria Luise* on June 10, 1913, en route to Germany. Dean Greene was vice-chairman of the Committee on Excursions. No better couple could have been chosen for the "Entertainment Committee led by Prof. and Mrs. A. M. Greene, Jr." Nineteen principal events, in which all passengers of the ship were invited to participate, provided an enjoyable program out of which lifetime associations sprang. For more than forty years this couple continued to create an atmosphere of happiness for themselves and for their friends, colleagues, and students, until Mrs. Greene's death in January, 1949.

On St. Patrick's Day, 1902, the lassitude which has accompanied the vernal equinox ever since time began inspired the mechanical-engineering students at Missouri to declare an unscheduled holiday. St. Patrick, it was discovered, was the first mechanical engineer, for had he not started the "worm drive," was not the shamrock a trifoliolate variation of the symbol of ASME, and hence was he not the patron saint of all engineers? It is said that Professor Greene could not at first condone the high-handedness of students who created their own holidays but that later he was convinced of the appropriateness of the occasion and became an honorary knight. Other colleges were not slow to follow Missouri in celebrating St. Pat's day and, as is well known, the custom of a holiday on March 17 has spread to many campuses.

* * *

In 1906 Professor Greene was made junior dean at Missouri's School of Engineering, but the following year he resigned to become professor of mechanical engineering at Rensselaer Polytechnic Institute. Into the life of Troy and the Institute he immediately threw the whole weight of his personality, energy, and enthusiasm. He inaugurated and planned the new course in mechanical engineering and the mechanical and hydraulic laboratories to meet the requirements of the Institute. He was in charge of the heating plant and designed the mechanical equipment of all the buildings during his stay at RPI, which extended from 1907 to 1922. When he resigned to take up his duties at Princeton, RPI conferred on him the honorary degree of DEng.

A year after Professor Greene's arrival at RPI he was joined there by a young man, Lewis Ferry Moody, Honorary Member ASME, whose recent death was noted in this space in the August issue. Moody had been an undergraduate at Pennsylvania during Greene's period of service there and had stayed on for two years as an instructor after Greene had left. In 1909 Moody married Greene's sister, Eleanor Carman Greene. This family relationship cemented the bonds of friendship and of mutual admiration and interests which held the two men together for the rest of their lives.

* * *

The full flowering of Arthur Greene's career, if not its climax also, developed at Princeton. Since 1875 there had been an undergraduate curriculum in civil engineering and in 1889 graduate studies in electrical engineering had been introduced. But there were no undergraduate curricula in other traditionally recognized branches of engineering such as students might expect to find in a great university. This deficiency was called to the attention of President Hibben by Princeton alumni, and it was announced at the 1921 Commencement that the University planned to offer undergraduate curricula in mechanical, chemical, and geological engineering, in addition to that already existing in civil engineering, and would add an undergraduate curriculum in electrical engineering. To organize this School of Engineering, Professor Greene was called in 1922 as its first dean and professor of mechanical engineering. In addition to organizing an engineering school and its faculty, Dean Greene directed the design of a new engineering building, and continued to interest himself in community and national affairs and to act as a consultant engineer in the fields of power plants, manufacturing, housing developments, and printing. When he retired in 1940 he was a consultant with some fifteen different organizations. During the eighteen years he had served the University, enrollment in the School of Engineering had grown from 84 to about 400 students. Release from the burdens of administration of the School of Engineering did not end Dean Greene's activities. His interests in the learned and professional societies of which he was a member continued, and throughout the remainder of his life he held classes at Princeton.

* * *

Academic duties as teacher and administrator, onerous as they were, did not prevent Dean Greene at any time during his lengthy career from engaging in consulting practice and as an expert in patent and other causes. Nor was he neglectful of his responsibilities to the community, to the nation, and to his profession. At Troy he was a trustee of the YMCA, the Public Library, and the First Presbyterian Church. During World War I he was a "four-minute man," a member of the War Committee of the Technical Societies, the War Service League of Troy, and chairman of the Rensselaer County Power Plant Committee of the U. S. Fuel Administration. He entered heartily into the activities of the Society of Engineers of Eastern New York and the Society for the Promotion of Engineering Education (now named the American Society for Engineering Education), both of which he served as president. Naturally, too, he took part in the affairs of The American Society of Mechanical Engineers as member, committeeman, and officer.

This pattern of devotion to duty and active participation in whatever cause he espoused was followed by Professor Greene throughout his long and useful life. After he had taken up residence at Princeton, he became a member of the Governor's Highway Safety Council of New Jersey, of the New Jersey State Board of Professional Engineers and Land Surveyors, of the War Price and Ration Board, and of the Board of Education, Princeton. Continuing his practice as consultant engineer for power plants and manufacturers, and as expert in patent causes, he served also as consultant of the Co-ordinator of Inter-American Affairs, as consultant of the War Production Board, and as expert consultant of the Army Specialized Training Division, U. S. Army. In 1930 and 1936 he was a member of the Engineering Division, National Research Council, and of the Belgian American Educational Foundation. Among his many honors was the silver medal of the Jugo-Slovakian Red Cross. He served as a member of the American Engineering Council and The Engineering Foundation. He was a member of the Guild of Brackett Lecturers, Princeton University, the Newcomen Society, Sigma Xi, Phi Beta Kappa, Tau Beta Pi, and other honorary societies, and was an honorary member of the Princeton Engineering Association.

* * *

Dean Greene became a junior member of ASME in 1895, a Member in 1903, a Fellow in 1936, and an Honorary Member in 1940. Throughout this period of almost sixty years he served the Society in capacities too numerous to mention completely. He was elected to the Council as a manager in 1913 and as a vice-president in 1916. He was a member of the Research Committee for ten years and of several of the special research committees, including those on Properties of Steam and Extension of the Steam Table, and on Gears; and of several joint committees of ASME and other engineering societies and organizations. He also served four years on the technical committee on General Instructions of the Power Test Codes Committee and as chairman of the Awards Committee.

Dean Greene's longest period of service on any ASME committee was that with the Boiler Code Committee. It will be remembered that this Committee of seven members was originally appointed in 1911 as the Committee to Formulate Standard Specifications for Construction of Steam Boilers and Other Pressure Vessels and for Their Care in Service, and that on Dec. 14, 1914, an advisory committee of eighteen men was named to work with it. Dean Greene was one of the advisory committee members, and his appointment provided a representative of the interests of engineering education. On Feb. 13, 1915, the two committees were merged and became known as the Boiler Code Committee. He became an honorary member of that committee in 1943, having served actively as member and chairman of several important special, joint, and subcommittees for a period of about thirty years.

During the fifty years that followed the publication of his first textbook, already mentioned, Dean Greene found time to write nine others. His many technical articles appeared in ASME and other publications. Several years ago, when it was decided that a comprehensive history of the ASME Boiler Code should be prepared, Dean Greene was persuaded to undertake the task. Eight chapters of this history have appeared in MECHANICAL ENGINEERING, and two additional chapters which carry the history through the edition of the Code of 1943, the last edition in which he had participated as an active member of the Committee and the last chapters he had planned to include in his great work.

A history of the ASME Boiler Code was a tremendous task for a man approaching eighty to undertake. It involved a study of boiler history and safety rules prior to 1911, a close reading of the minutes of the Boiler Code Committee and the ASME Council, and the many editions of the Codes; the painstaking checking of names and dates; the physical labor of preparing a handwritten text; the weary hours of correcting typescript, galley proofs, and page proofs; and almost weekly trips between Princeton and New York. On July 8 of the current year his part of the work was completed.

* * *

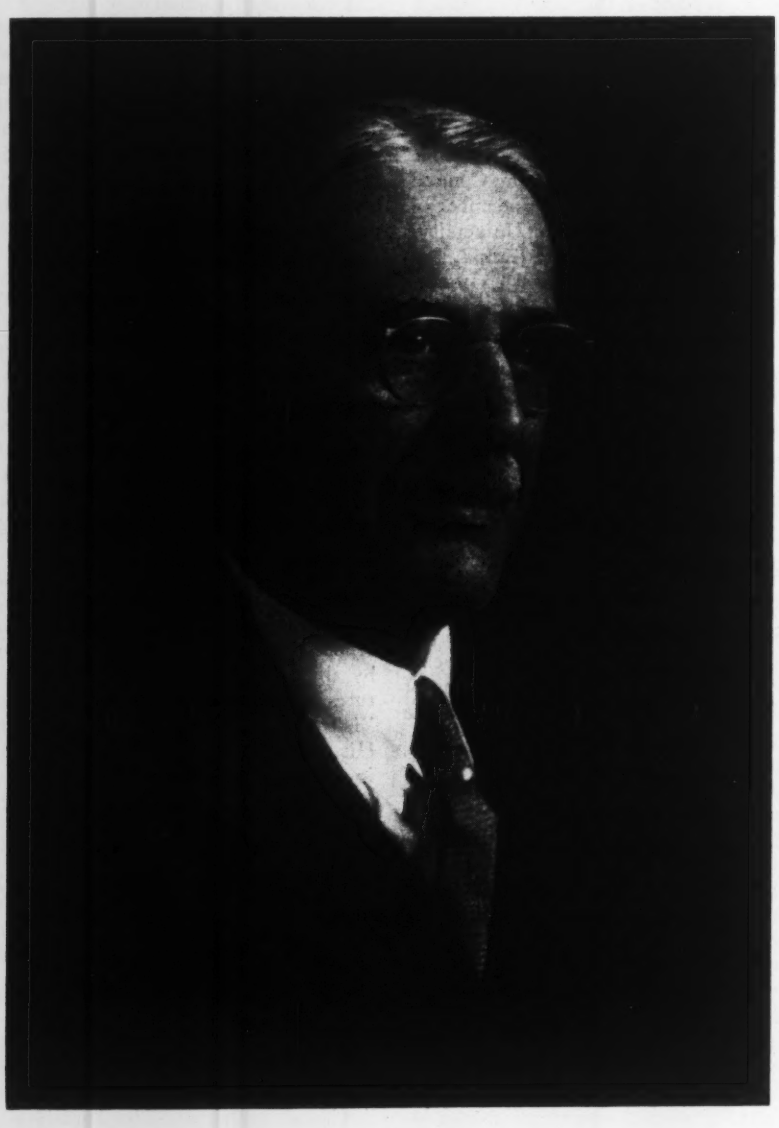
The high ideals which Dean Greene held for engineers and the engineering profession were amply reflected in his own life and found a responsive atmosphere for development at Princeton. It was the "whole man" that he desired to nurture in the youths who came under his instruction and to see fully developed in their mature years. He is quoted as having stated that "the imagination of the engineer should be equal to that of the novelist, the artist, the poet, or the preacher, for in many respects the work of all these creators is the same in the development of the complete whole." With breadth of vision, knowledge, and understanding he required also a stern integrity and meticulous accuracy which are essential elements of the physical sciences, pure and applied. Studies which discipline the mind must be supplemented by ability to convert fundamental principles into structures, machines, and processes. "The student," he wrote, "is trained to act upon deduction from definite premises. His course includes the design of structures, the projecting of experiments, and the prediction of results which are tested by the actual completion of the device, test, or operation. The work of the engineer being such that success or failure can be measured by all, his training is planned to make him realize that only from true premises can actual results be predicted. Definite things must be known before definite things can be surmised, and he learns to deal with realities even though they originally may be creatures of the imagination."

* * *

Cheerfulness and kindliness stand out as two engaging qualities of Dean Greene's personality. It was always a joy to look up and see him enter the room with a hearty informal greeting. The loosely fitting blue suit ("I wear blue because my dear wife liked it"), the felt hat that had grown comfortable to wear at the expense of its sartorial effect, the battered briefcase, often agape, whose burden increased the slope of one shoulder, the ubiquitous pipe, all these characteristics of physical ap-

pearance were forgotten in the warmth of a friendly smile and the keenly alert expression of the eyes. One remembers the long hours spent in the checking of proof. A name brought forth an anecdote. What seemed to be an obscure passage sent his mind back over the years with an off-the-record explanation of the background and personalities, for of these matters he had been a part. A query about a date or the spelling of a name brought forth the promise, "I'll check that." A suggestion for rephrasing a sentence was magnanimously accepted or countered with a better choice of words. Discovery of the verb at the end of the sentence would bring forth a comment about "my German style of writing." They were happy, profitable hours which have left recollections, trivial and significant alike, of a great man.

On July 8 the last galleys of the History of the ASME Boiler Code, perhaps the climatic professional achievement of Arthur Greene's life, were complete. "I leave it all in your hands, my boy," he said, "in case the old man pops off."



Arthur M. Greene, Jr. 1872–1953

DESIGN *Considerations Associated With Large* ALUMINUM FORGINGS

By CHRIS W. ANDREWS

ASSISTANT CHIEF OF STRUCTURES, DOUGLAS AIRCRAFT COMPANY, INC., LONG BEACH, CALIF.

THE quest for superiority in air power brings constantly increasing demands for higher performance. The satisfaction of these demands presents many challenges to the aircraft industry. These challenges are being met by the resourcefulness and ingenuity of designers, by the painstaking labor of research laboratories, and by the skill of test pilots. The co-ordinated efforts of the many related industries and organizations also are aiding these endeavors through the development of technical information, equipment, materials, and machinery necessary for the design and manufacture of a complete aircraft.

The contribution to higher performance can be accomplished by the structural designer in the development of greater efficiency in structure: (1) By the selection and distribution of material giving the maximum possible strength-weight ratios; (2) by the elimination of joints and their inherent inefficiencies and eccentricities; (3) by greater refinement of analysis; (4) by the maximum utilization of testing to obtain efficiency in components which are difficult to analyze; (5) by the design of multipurpose instead of monopurpose elements; (6) by proper consideration of the importance of external structure design to aerodynamic efficiency; and (7) by considering the importance of rigidity in the basic structure to dynamic efficiency.

The greatest efficiency may result in the evolution of an aircraft having a single homogeneous structure. Idealistic as this philosophy may appear, an approach to this goal is being attempted by the gradual development of larger single structural components. Advances made in the production of materials and material forms such as extrusions, castings, plate, sheet, and forgings, and the existence of supporting equipment and machinery for fabricating these materials have permitted an expansion of the designer's structural concepts. The utilization of large forgings in modern aircraft is a part of this concept.

Most designers will agree that a gain in structural efficiency and performance can result from the use of a larger component properly designed. Other factors, however, also must be considered. Decisions relative to the usage of large forgings must compromise all the factors in a manner which will produce the greatest net gain to the aircraft. The importance of one factor over another may be dependent upon the type of aircraft under design. An extremely high-performance military aircraft may require prime emphasis on strength and weight, while a commercial transport may require equal emphasis on cost, and other types of aircraft may require high emphasis on producibility. Complete evaluation of the design problem and the use of good judgment are the primary requisites in the selection of components for large-forging design. As forgings grow larger, several factors appear to warrant special consideration: (1) strength, (2) weight, (3) cost, (4) availability, and (5) quality.

Contributed by the Aviation and Machine Design Divisions, Society of Automotive Engineers, and Institute of Aeronautical Sciences and presented at the Semi-Annual Meeting, Los Angeles, Calif., June 28–July 2, 1953, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

STRENGTH

Since forgings, in general, are used for primary structural components, an awareness of the effect of forging size on strength characteristics is very important. In considering strength, the plan area of the forging is not particularly critical; however, the thickness and cross-sectional area are critical, for as they increase, the material properties decrease in two important ways:

1 The material becomes less uniform and is lower in strength and ductility. This condition results from a reduction in working of the material especially toward the center of the billet.

2 The ductility of the material becomes more directional with a marked decrease in the transverse directions. Lowest ductility is encountered in the short transverse directions.

These conditions are of particular importance in aluminum alloys. Variations in strength and elongation in specified directions with respect to area and thickness are shown in Tables 1 and 2. These data are applicable specifically to 14S and 75S hand-forged billets within the limits indicated. It can be noted that in 75S material the ultimate longitudinal tensile strength of billets less than 16 sq in. in area is 4000 psi greater than billets exceeding 36 sq in. in area. In the same billets, elongation in the longitudinal direction varies from 9 per cent in the small billets to 4 per cent in the large billets.

The differences in strength and ductility become even more pronounced as directionality, illustrated in Fig. 1, is considered. A longitudinal element in a small billet develops an ultimate tensile strength of 75,000 psi while a short transverse element in a large billet develops only 64,000 psi.

Although the foregoing examples refer to hand-forged billets, equivalent differences are likely to exist in die forgings with similar thicknesses and cross-sectional areas. An accurate prediction of strength characteristics in any specific section of a die forging is difficult since the forging techniques and procedures can influence properties. The only reliable sources presently available for the determination of strength allowables in large die forgings, with thicknesses exceeding 3 in., are test specimens from the actual die forging, past experience with similar designs, and the predictions of qualified forging experts. In the early design stages, therefore, it is essential that close co-ordination be maintained with the forging vendor so that design recommendations leading to better properties can be incorporated and guarantees can be negotiated. Desired strength characteristics are not produced in a part merely by specifying allowables on a drawing. On the other hand, efficient design cannot be developed unless minimum values are established. A compromise must be reached and it should be resolved before the design is completed.

The reduction of strength and elongation with increases in thickness are natural phenomena with metals, as is the increase in notch sensitivity with increases in ultimate strength. Neither has serious consequences as long as the designer is aware of the condition and provides for it in the design. Good design takes advantage of the desirable qualities of a material

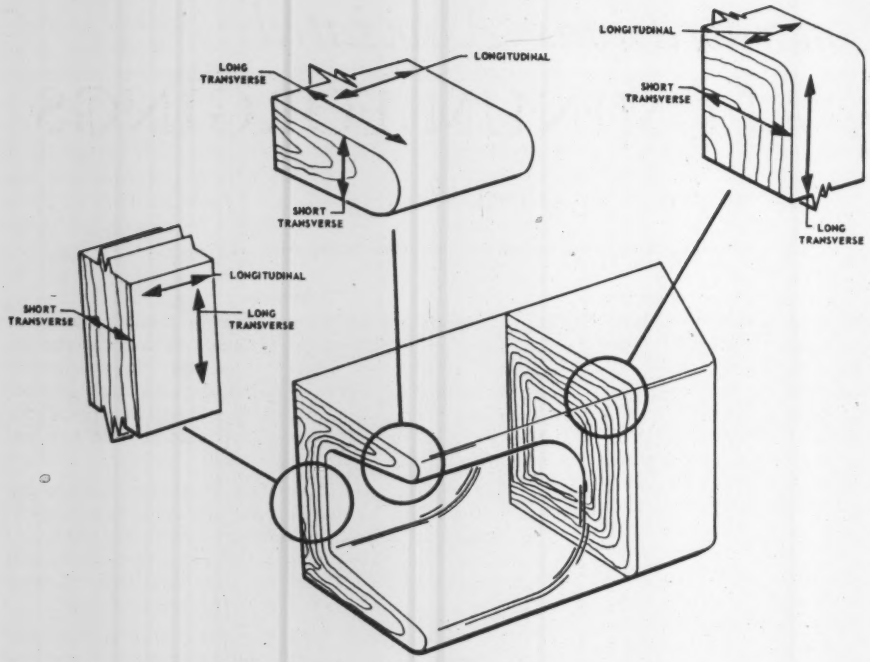


FIG. 1 DIRECTIONALITY

and avoids the pitfalls created by the undesirable qualities. With the growth in forging size, it is essential that the following precautions complement the normal design practices employed in smaller forging design: (1) Maintain the smallest possible cross-sectional area compatible with final part requirement; (2) avoid excessive thickness; (3) avoid loading in the short transverse direction; (4) account for reductions in strength and elongation due to size effects; (5) consult freely with qualified forging vendors in the early design stages; (6) specify rough-machining of forging prior to heat-treatment in order to obtain maximum material properties and corrosion resistance; and (7) carefully consider the grain direction for orientation with respect to loads.

WEIGHT

The potential of weight reduction is one of the prime reasons for encouraging the use of large forgings. Substantial savings in weight can result from the elimination of joints and eccentricities and a more efficient disposition of material. The penalties imposed by splices in highly loaded members and the attachment of major fittings are well known. Any device which can minimize these penalties must be employed. Care must be exercised, however, to prevent weight penalties resulting from the use of the forging itself.

The attainment of maximum efficiency in structure demands that a minimum amount of material be used and that this material work to the highest possible stress level. In beams, the web thickness should be no greater than required by the shear load. The caps should taper in area with the variation of bending moment to maintain high stress levels. The beam-cap centroids must be as far removed from the neutral axis as possible to produce maximum section properties for minimum weight. These requirements have brought demands for thinner webs and smaller draft angles in die forgings. If suitable thickness and draft cannot be produced in the die-forging blank, then they must be machined into the finished part. The design must

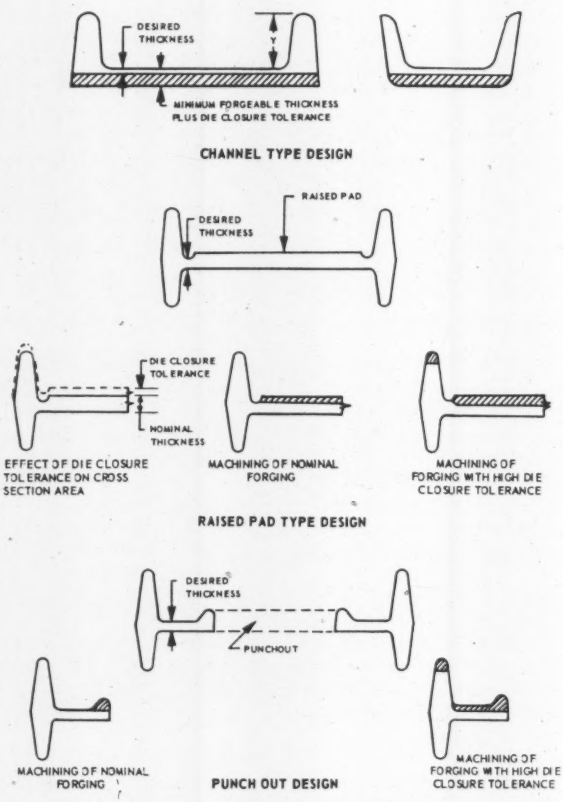


FIG. 2 DESIGN CONFIGURATIONS

TABLE 1 MINIMUM MECHANICAL PROPERTIES OF 14S-T6 ALLOY HAND-FORGED SQUARES, ROUNDS, AND RECTANGLES[a]

Area	Length	Tensile strength, psi			Yield strength, psi (0.2 per cent offset)			Elongation per cent in 2 in.		
		Longitudinal	Long transverse	Short transverse	Longitudinal	Long transverse	Short transverse	Longitudinal	Long transverse	Short transverse
Up to 16 sq in. incl	Up to 3× width, incl.	65000	62000	59000	55000	55000	55000	10.0	6.0	3.0
	More than 3× width	65000	62000	59000	55000	55000	55000	10.0	4.0	2.0
Over 16 to 36 sq in. incl	Up to 3× width, incl	65000	62000	59000	53000	53000	53000	9.0	5.0	2.0
	More than 3× width	65000	62000	59000	53000	53000	53000	9.0	3.0	1.0
Over 36 to 144 sq in. incl	Up to 3× width, incl	62000	59000	56000	50000	50000	50000	7.0	3.0	1.0
	More than 3× width	62000	59000	56000	50000	50000	50000	7.0	2.5	1.0
Over 144 to 256 sq in. incl	Up to 3× width, incl	60000	57000	54000	48000	48000	48000	5.0	2.0	1.0
	More than 3× width	60000	57000	54000	48000	48000	48000	5.0	1.5	1.0

[a] From Aluminum Company of America Booklet "Hand Forgings," March 3, 1952.

TABLE 2 MINIMUM MECHANICAL PROPERTIES OF 75S-T6 ALLOY HAND-FORGED SQUARES AND RECTANGLES

Area	Length	Tensile strength, psi			Yield strength, psi (0.2 per cent offset)			Elongation per cent in 2 in.		
		Longitudinal	Long transverse	Short transverse	Longitudinal	Long transverse	Short transverse	Longitudinal	Long transverse	Short transverse
Up to 16 sq in. incl	Up to 3× width, incl	75000	75000	72000	64000	63000	63000	9.0	4.0	1.0
	More than 3× width	73000	73000	70000	62000	61000	61000	8.0	3.0	1.0
Over 16 to 36 sq in. incl	Up to 3× width, incl	73000	71000	68000	61000	60000	60000	7.0	3.0	1.0
	More than 3× width	71000	69000	66000	59000	58000	58000	6.0	2.0	1.0
Over 36 to 144 sq in. incl	Up to 3× width, incl	71000	69000	66000	60000	58000	58000	4.0	2.0	1.0
	More than 3× width	69000	67000	64000	58000	56000	56000	3.0	1.0	1.0

NOTE: Properties guaranteed in sections not over 3 in. thick at time of heat-treatment.

recognize this condition and provide for economical reduction of thickness by machining.

Several design configurations, illustrated in Fig. 2, have been used to obtain desired thickness at low cost. The channel type of design is highly recommended where it can be used. The Y-dimension can be held accurately since the cavity is entirely within one die and the die-closure tolerance is accumulated in the web which can be reduced easily in thickness by a simple slab-type cut. As a result, the weight of such parts can be quite consistent. The raised-pad type of design can be used where an I-section is desired. This configuration is satisfactory if there is zero die-closure tolerance. If large closure tolerances exist, this type of design may not prove advantageous and weight control with simple minimum machining may not be possible. The system of providing punchouts is also satisfactory, providing die-closure tolerances can be minimized.

It is undoubtedly true that web thicknesses will decrease as the larger-capacity presses go into operation. Higher die pressures may produce thinner webs, but if die-closure tolerances continue to remain at their present levels, the achievement of thinner webs will be of little value. Assuming that a 5 per cent weight tolerance is reasonable in an aircraft this would require that forgings with 0.250 webs have a die-closure tolerance of 0.0125 in. Tolerances of this magnitude may be possible but the recommendation for die-closure tolerance by forging vendors on a part 1200 sq in. in area with 0.75 in. web thickness was 0.19 (25 per cent of the web thickness). In terms of weight, this additional material would amount to 22 lb per forging if it were not removed by machining. Areas exceeding 2000 sq in. probably will be common with the operation of 35,000-ton and 50,000-ton presses. At that time even the tolerances on machining must be considered carefully. In 2000 sq in., a tolerance of 0.03 in. increases the weight 6 lb. Although this tolerance may be considered reasonable by some, it is an indication of weight penalties induced even by small tolerances. Proposals partially to machine rough forgings prior to the finish die operation may alleviate the web-thickness and die-closure problem.

It is hoped that eventually the larger presses may reduce the variations in weight through closer tolerance control. In the meantime, the effect of present tolerances on weight must be considered and the excess weight must be removed.

COST

Experience has proved that savings in money, manpower, and elapsed time can be achieved by the substitution of well-designed single-forged units in lieu of complicated multipiece assemblies. The determination of a plus or minus sign in front of the dollar sign is dependent upon the designer's ability (1) to select the proper application, (2) select the proper material, (3) use known design practices which minimize die cost, and (4) blend the forged blank and finished product designs so that complex machining is avoided.

Forgings are generally used where their qualities of strength, grain orientation, and material disposition are most useful. In view of the large tolerances associated with forgings, it would be foolish to use forgings where closer tolerance extrusions could be used at no penalty in strength and a possible saving in cost. Typical applications for large forgings are wing spars, heavily loaded frames, ribs and bulkheads, floor beams, gear-support structure, and major attach fittings. Most of these examples represent flat-webbed beam or truss-type construction and lend themselves to reasonable forging production. Complex single or double-controlled elements in large sizes may be possible in the new heavy presses. As the design deviates from a flat plane, however, die-machining becomes more difficult, side thrusts are induced, and, in general, costs rise severely.

In aircraft design, two aluminum forging alloys, 14S and 75S, are generally used. The selection of one over the other can influence cost as well as strength. 75S material is more difficult to forge. As a result, more stage dies are required, the number of operations is increased, and die life is reduced. Obviously, die cost and piece price will be higher. Conservative estimates place a 20 to 30 per cent cost penalty on the use of 75S in lieu of 14S because of these factors. In some applica-

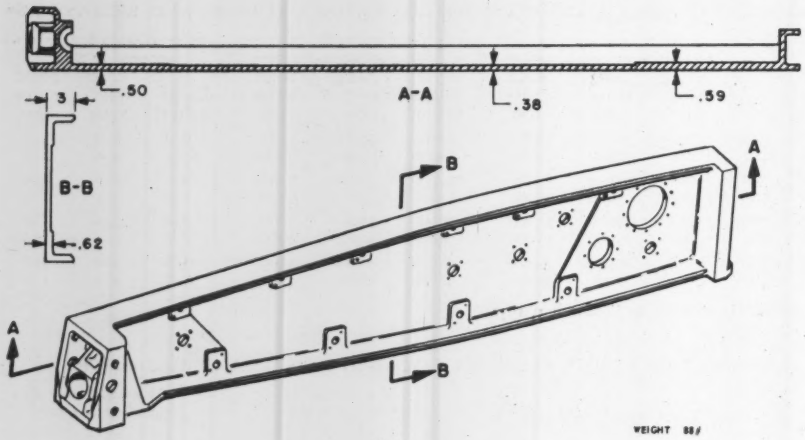


FIG. 3 SWEPTWING ROOT-BULKHEAD FINISH-MACHINED PART

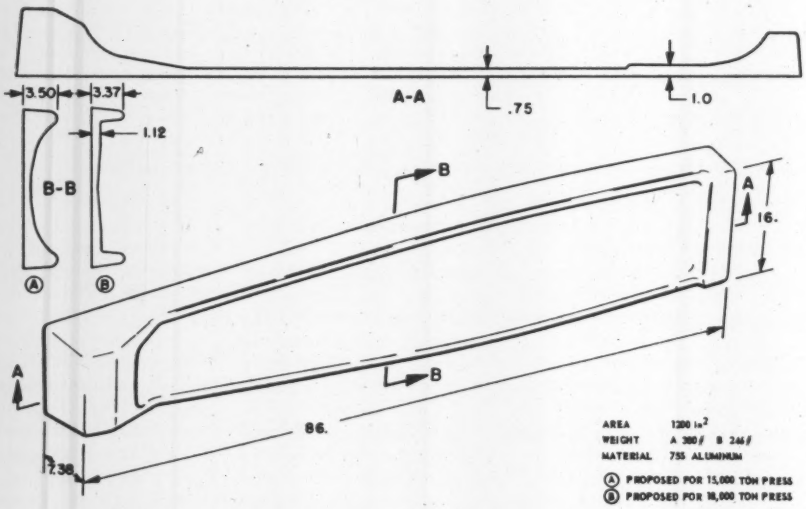


FIG. 4 SWEPTWING ROOT-BULKHEAD FORGING

tions, 14S could be specified without penalty, particularly where rigidity requirements set the design criteria.

Design suggestions for economical production of dies and parts can be found in forging handbooks and drafting-room manuals. The information contained in them applies equally to large die forgings, although experience with the new heavy presses may revise some of the more conservative recommendations.

The relationship of the forging blank to the finished part is probably more important to cost than any other consideration. The variation in cost with forging-blank design is well illustrated in the following example: Fig. 3 shows a single-piece wing bulkhead fabricated from a 75S forging. The area of this bulkhead is 1200 sq in. On the basis of present standards, it was felt that a refined die forging, (A), Fig. 4, would require at least a 35,000-ton press. This press was not in operation yet and deliveries could not be expected in time for production requirements. Decisions were made, therefore, with the aid of the forging industry, to develop an interim design capable of being produced on existing 15,000-ton or 18,000-ton presses. The blocker-type design proposed for the 15,000-ton press is shown as (A) in Fig. 5; (B) is the design for the 18,000-ton press. Further studies by the forge shop indicated that a more detailed die forging, (B), Fig. 4, might be produced on the 18,000-ton press. For immediate use, a hand-forged billet, Fig. 6, was ordered.

TABLE 3 COST RELATIONSHIP OF SEVERAL FORGING DESIGNS FOR WING BULKHEAD

Design type	Total unit cost, per cent	Die cost—set-up charge and piece price, per cent	Machining and tooling cost, per cent
Fig. 6 hand-forged billet	100	39	61
Fig. 5(*A*) blocker die 15,000 ton	77	43	57
Fig. 5(*B*) blocker die 18,000 ton	72	46	54
Fig. 4(*B*) semidesired forging 18,000 ton	63	61	39
Fig. 4(*A*) desired die forging 35,000 ton	?	?	?

Estimates were obtained on the total cost of the material, including die cost, piece price, and set-up charges. Similar estimates were made of the machining costs to reduce the various blanks to finished parts. The relationship of these costs is noted in Table 3. The most expensive configuration, naturally, was the hand-forged billet. The total unit cost of the hand-forging was established as unity and the other configurations are compared to it in terms of a percentage. The relative cost of material and machining also are shown for each con-

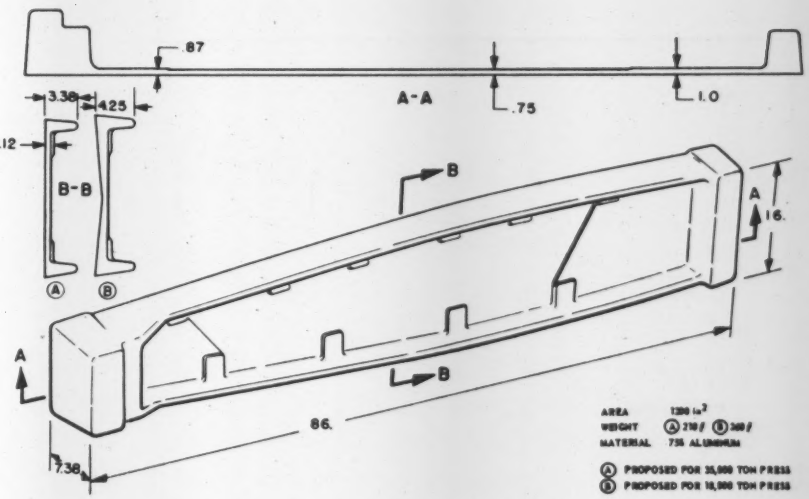


FIG. 5 SWEPTWING ROOT-BULKHEAD BLOCKER-TYPE FORGING

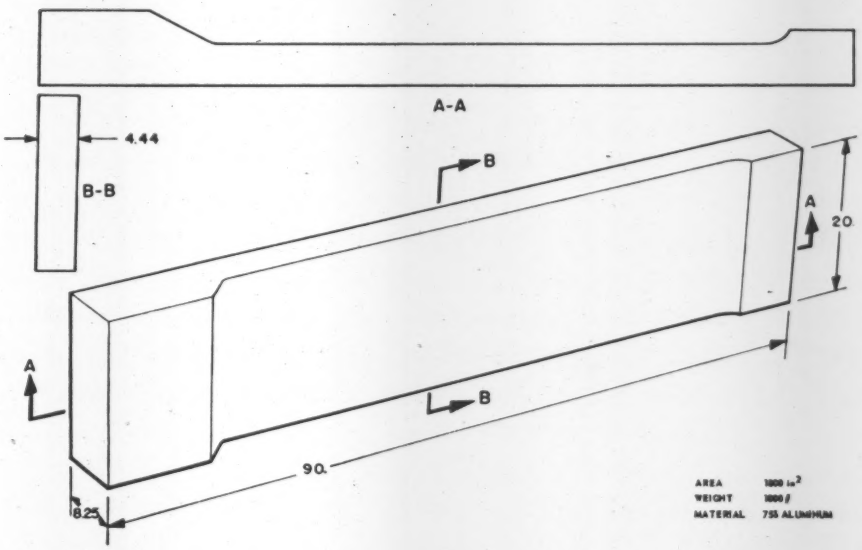


FIG. 6 SWEPTWING ROOT-BULKHEAD HAND-FORGED BILLET

figuration. The significance of this comparison is that the material cost in terms of dollars remained fairly constant. The saving in total unit cost resulted primarily from reduced machining costs. Closer-tolerance forgings, even at increased die costs, may prove to be the most economical over-all approach.

Figs. 7, 8, 9, and 10 illustrate additional large forging configurations and their relationship to finished-product requirements.

AVAILABILITY

The design of an aircraft, or any element of that aircraft, is the beginning of a cycle. The cycle ends when the last unit of that model ceases to exist. In the meantime, aircraft must be built within specified time limits and in specified quantities. The availability of material, therefore, is of major concern.

The forging industry at this time has two heavy presses capable of relatively large-forging production, the Wyman-Gordon 18,000-ton press and the Alcoa 15,000-ton press. Four additional presses are contemplated. Two will have a capacity of 35,000 tons and two a capacity of 50,000 tons. The first of these presses is scheduled for delivery early in 1954 and the last press late in 1954. The operation of these presses should provide a substantial increase in large-forging production capacity.

Up to the present time the possibility of a press breakdown in either of the two operating presses, with some justification, has caused a reluctance to incorporate large-forging designs into production airplanes. With the completion of the new presses, the breakdown problem does not appear acute. The combination of a 35,000-ton press and 50,000-ton press in each forge shop, should permit continuous production if the dies and designs are compatible to both presses. It is recognized that a forging designed for the 50,000-ton press may not be produced to desired tolerances in the smaller press, but complete stoppage of production could be avoided. It may be well for the designer and the forging producer to consider this possibility.

The probability of die breakage also has caused some concern. As forgings grow larger, pressures undoubtedly will go higher and die-block sizes will increase. Higher pressures may lead to more frequent die failures. It is imperative, therefore, that

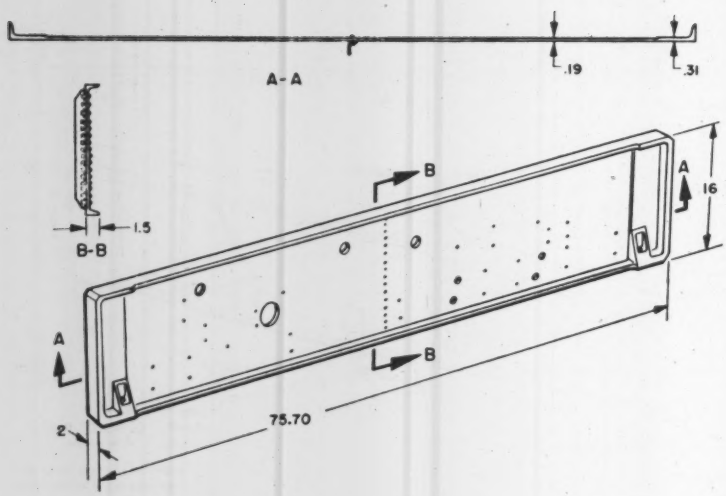


FIG. 7 CONSTANT-SECTION SPAR FINISH-MACHINED PART

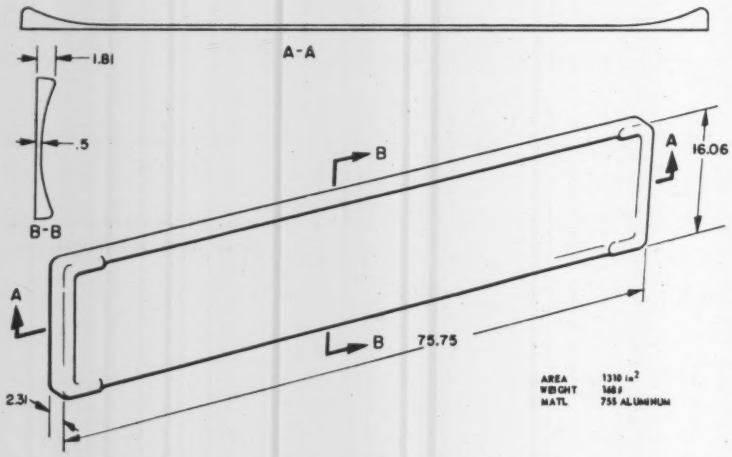


FIG. 8 CONSTANT-SECTION SPAR BLOCKER-DIE-TYPE FORGING

the designer avoid poor design practices which lead to die-checking or other types of die failure. Failures normally occur in the finish-stage die. In this event, forgings from the blocker-stage die may still be available. However, the use of blocker-die-type forgings may hamper production schedules seriously owing to the increased machining required. A substantial quantity of milling equipment will be required to finish die forgings. It is doubtful that an additional demand could be placed on this equipment except for emergency purposes. Large-forging proposals for the new presses probably should proceed on a somewhat conservative design basis until their capabilities of sustained production are proved. Large die blocks are long-time procurement items and die-sinking time is difficult to find. In those cases where an easy substitution can be made, or an existing element is redesigned, a more radical

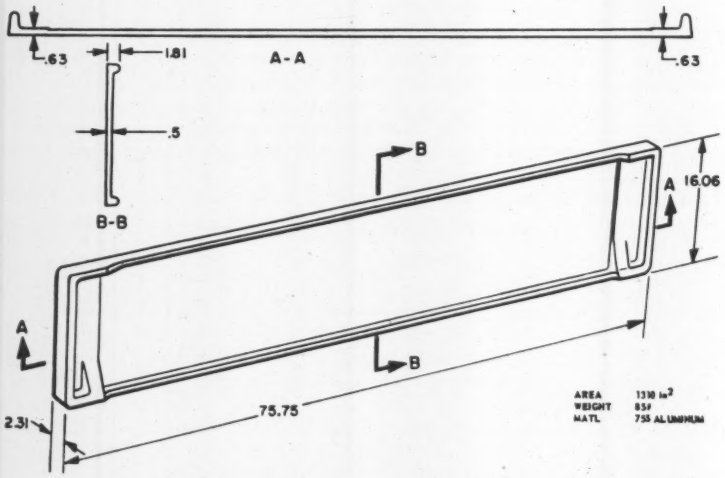


FIG. 9 CONSTANT-SECTION SPAR DIE FORGING

design approach possibly can be attempted without danger of disrupting schedules.

In considering availability, the designer also must determine whether sufficient milling capacity exists for transforming the forging to a finished usable part. Standard milling equipment will not be able to finish some of the large forgings contemplated. Large special equipment will be required, and the availability of this equipment may influence the use of a large forging.

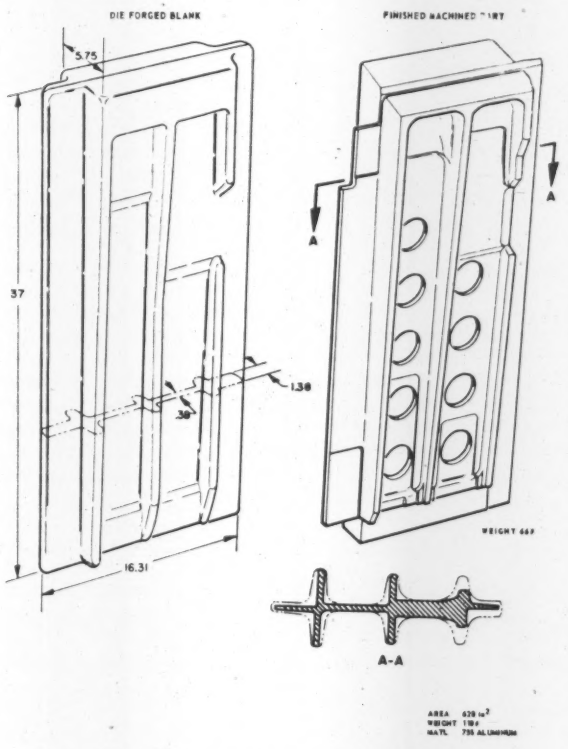


FIG. 10 WING SPAR-TO-FUSELAGE ATTACH FITTING

QUALITY

It is difficult to anticipate the effect of increased forging size on quality. The ability to produce larger ingots of good quality has not yet been established. If the material is sound in the ingot form and proper design is employed, the resulting forging should turn out well. Most forging defects, such as laps, flow-through, and cracked fillets, are visible on the surface and can be detected easily. Unhealed porosity, however, requires the use of ultrasonic-inspection devices for detection in most cases. As forgings grow larger it may be necessary to refine the quality-control procedures and expand the sonic-inspection methods to assure high integrity.

Warpage may not be classed as a quality item. However, it is an occurrence which is troublesome and can affect the quality of the end product. Residual stresses induced by the heat-treating process are the main cause of warpage. Heat-treatment and machining procedures both have a tendency to relieve these stresses thus permitting the forging to twist or bend. Stretcher-leveling of constant-area extrusions, bar and plate in the "SW" condition to relieve residual stresses has reduced substantially warpage resulting from these causes. Forgings, unfortunately, do not lend themselves to stretcher-leveling. The designer therefore must recognize this problem in the initial design. The finished part may not be obtainable from the forging unless sufficient material is provided for rough-machining prior to heat-treatment and for finish-machining after the heat-treatment and straightening operations. In some forgings a long period of machining-technique development was required before a successful finished part could be obtained. Accurate forgings, heat-treated and straightened by the forging vendor which require minimum machining by the airframe manufacturer, someday may solve this problem. Some consideration has been given already to the possibility of preliminary machining of the forging billet by the producer to achieve this goal.

SELECTION AND DESIGN OF A LARGE FORGING

The following example illustrates the requirements which lead to the selection of a forging for the root bulkhead of a typical sweptwing airplane, Fig. 11, and the factors considered in its design.

This bulkhead is located at the junction of the sweptwing panel and the constant-section panel at the side of the fuselage. Because of its location, several design requirements were established quickly.

The skin and stringers which carry the axial loads, due to bending, change direction at this bulkhead. As a result, high load components are induced which act in the forward direction on the compression surface and in the aft direction on the

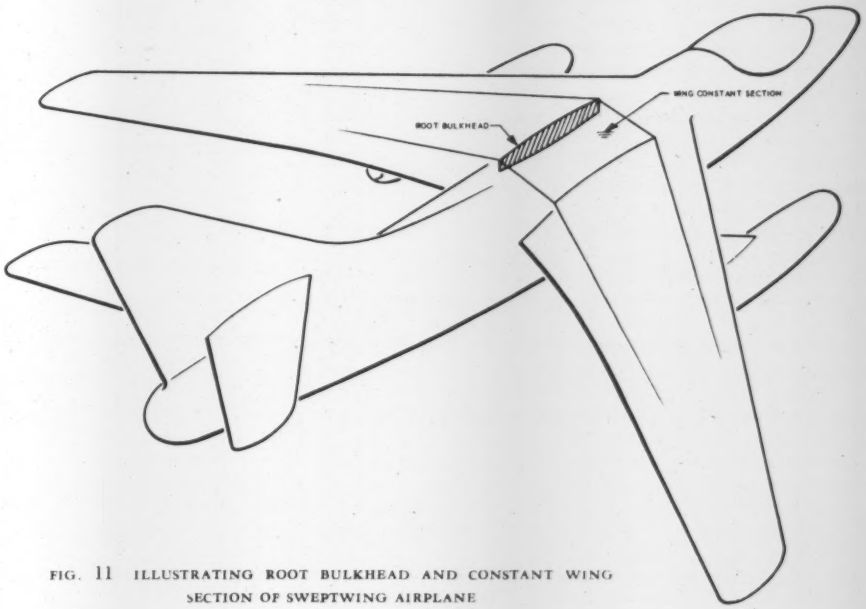


FIG. 11 ILLUSTRATING ROOT BULKHEAD AND CONSTANT WING SECTION OF SWEPTWING AIRPLANE

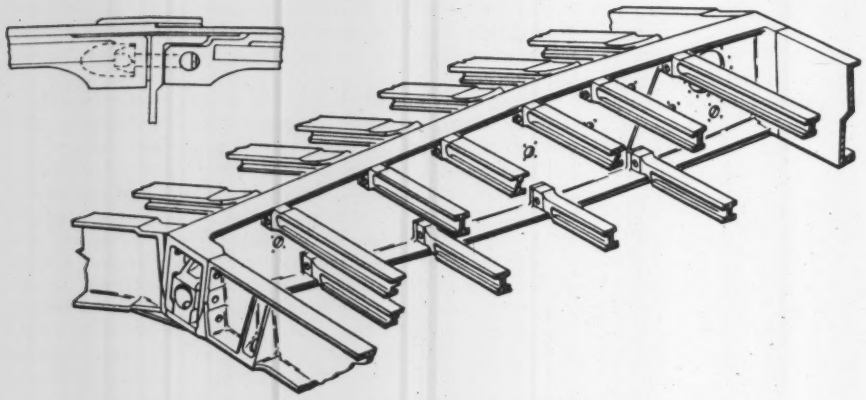


FIG. 12 INSTALLATION OF WING-ROOT BULKHEAD

tension surface. These loads increase in magnitude going from the front to the rear spar and add to or subtract from the wing torque. The majority of these loads can be resolved within the bulkhead. The forward loads at the top can be reacted by the aft loads at the bottom through shear in the bulkhead. The moments induced in the bulkhead are balanced by reactions at the front and rear spar.

In addition to carrying severe loads, this bulkhead forms the inboard closure of an integral fuel tank and as such requires careful consideration of fuel-sealing difficulties and equipment-mounting problems.

After an analysis of the requirements, it was decided that a single-piece bulkhead with a web that varied in thickness with the load and contained integral reinforcements at points of high load application and at mounting locations could best satisfy these requirements. The single-piece unit also would provide increased rigidity.

Several detailed design studies were initiated using various forging designs. One design utilized an I-type section so that the bulkhead also might be used to splice the skins. This type of design has some merit; however, it was discarded because the machining of the outboard leg and inboard leg of the cap to the wing contour with varying bevels was considered too complex and time-consuming. It also was felt that the application of tension loads spanwise across these caps would load them in a transverse direction which was not desirable.

The final design of this area, Fig. 12, incorporated a channel-type forging for the bulkhead, Fig. 3. Material was provided at the front and rear-spar areas to incorporate the wing-to-fuselage attach fittings as a part of the bulkhead since the major portion of the wing-reaction loads originated in the bulkhead rather than in the wing spars. The swept spars were attached to the outboard side of the attach-fitting portion of the bulkhead and spar shears were transferred by the bolted attachment. Spar-cap loads were transferred by the doublers. The swept stringers, fabricated from stepped extrusions, bolt through the bulkhead to the constant-section stringers.

The single-piece forging simplified the fuel-sealing problem since the only leak paths exist at the periphery of the forging which can be sealed easily. The equipment was mounted toward the front of the bulkhead which is the most lightly loaded, and material was added to compensate for cutouts and concentrations.

In general, good strength characteristics could be expected. The region near the spars required thicknesses and cross-sectional areas which were greater than desired. However, rough-machining was specified prior to heat-treatment to insure good properties in these regions, and margins of safety were considered carefully where the possibility of transverse loading was apparent. The elimination of the bits-and-pieces construction and the inclusion of the wing-to-fuselage attach fitting as an integral part of the bulkhead resulted in a substantial weight reduction. The channel-type design permitted the lowest possible die cost since only one die required a cavity. The reduction of web thickness with this type of design could be accomplished at low cost. The size of the forging required the use of a 35,000-ton press to obtain the desired configuration. Owing to the status of those presses, alternate designs were submitted for production to insure availability. Sound design practices were utilized throughout to assure good quality and sonic inspection is specified to determine the integrity of the material.

CONCLUSION

There is sufficient evidence from the existing presses to indicate that higher pressures can produce forgings with thinner webs and smaller draft angles. The grouping of equipment in the new press program provides greater assurance of availability. The capacity of the new presses implies an ability to produce larger forgings. The use of larger forgings from these presses provides the designer with an opportunity to obtain greater structural efficiency. This much is known about the large forging and heavy press.

There are, however, numerous questions to be answered. These answers are not yet available. In many cases, the specific design influences the answer. General statements relative to tolerances, die closure, die deflection, straightness, flatness, and the many other variations of interest to the designer cannot be made because each forging design has its own peculiarities and requires a special approach and solution. Size limitations are not known. Thickness limitations are not known.

Since there appear to be more unknowns than knowns, it becomes imperative that the producer and designer work in close co-ordination and remain constantly aware of the requirements and capabilities. Even in the field of co-ordination, some difficulties may be encountered owing to differing views of the requirements of some airframe manufacturers and the capabilities of various forging producers.

The future trend of forging design can be established only after comprehensive experience is obtained through the use of the new heavy presses. Until then, it may be well to temper our optimism with the recognition of our present knowledge of the forging art, and temper our pessimism with the confidence in our ability to solve problems as they arise.

ACKNOWLEDGMENT

The author wishes to express appreciation to Don Foster of the Douglas Aircraft Company Publications Group, for his valuable contribution in the preparation of the technical illustrations, and to George Ikola of the Douglas Aircraft Company, for suggestions contributed during the preparation of this paper.

ORGANIZATION *for* PRODUCTION ENGINEERING

By R. H. McCARTHY

SUPERINTENDENT OF MANUFACTURING ENGINEERING, WESTERN ELECTRIC COMPANY, KEARNY, N. J. MEMBER ASME

PRODUCTION-ENGINEERING PROBLEMS

MUCH of the skill of solving a group of problems is in selecting and stating the key problems accurately. Perhaps by accurately selecting and stating the key problems of engineering for production, the appropriate organization of production engineering efforts will become evident. For better definition, the following will be cut away from the direct problems of production engineers: general industrial accounting and financing; basic research; product development and design; distribution; advertising; public and industrial relations; plant protection; and supervision of productive personnel. This leaves a group of problems that require engineering. They commonly appear in the portion of the steps of an industrial project that are shown in Table 1.

The list is not intended to be exhaustive. It is generally chronological. A group that relates without question to product design can be selected. A group that relates to management of the people making the product can also be selected with fair accuracy. A third group in the middle of the series, steps 5 and 6 and 10 through 20, relates to conversion of design information into manufacturing information and to provision of manufacturing facilities.

This third group calls for a wide diversity of talents applied neither to the use of the product nor to the supervision of people who make it, but to problems of how to make it. The people who work on this group of problems must understand the product, its use, and the need to hold down costs. They must know processes and how to design the tools, machines, and factories that make the processes possible. They must cement product design to manufacturing processes with wise application of economics and human skills. The problems are in the field of engineering and can be solved by engineering methods. Whether we call the people solving these problems production engineers, manufacturing engineers, or industrial engineers, is not important. All are about equally expressive. To call them efficiency engineers, methods engineers, or time-study engineers does give wrong emphasis and restricts the field.

Having brought attention to natural groupings in Table 1, the error of isolating groups of problems has to be recognized. The problems of design are inseparable from those of manufacturing processes. The problems of processes cannot be separated from those of personnel management. Hence a product design organization must keep an eye on and identify itself with activities in the province of production engineering. Likewise, production engineering must work on product design. Corresponding overlapping should occur between production engineering and shop supervision.

In spite of such overlapping, it is possible and essential in good practice to define and assign in writing the functions and responsibilities of these three groups. Specifically all responsibility for the design of the product should be the designers.' As a corollary, all changes of design, whether they originate in or out of the design organization, should be cleared by it. Similarly, if production engineers are responsible for manufacturing methods, all changes of methods should clear through them. In the same way, all instructions to workers should clear through shop supervision.

TABLE 1 STEPS OF AN INDUSTRIAL PROJECT

1	Research
2	Development
3	Model construction
4	Model trial
5	Manufacturing review
6	Preliminary cost estimate
7	Design
8	Trial installation
9	Final design, specification and first issue of drawing
10	Manufacturing analysis
11	Inspection analysis
12	Material-handling analysis
13	Facility analysis
14	Facility design
15	Final cost estimate
16	Facility procurement and installation
17	Tool-made sample review, approval
18	Job-rating analysis
19	Wage-incentive analysis
20	Quality-assurance planning
21	Production programming
22	Piece-parts production and test
23	Subassemblies production and test
24	Final assembly production and test
25	Inspection
26	Packing and shipping

RESPONSIBILITIES OF PRODUCT DESIGNERS

Before proceeding with the responsibilities for manufacturing methods and processes, the responsibilities for product design should be examined. At one extreme, manufacturers of incompletely designed and noninterchangeable products spread responsibility for product performance indistinctly over the product designer and the maker. At the other extreme, manufacturers of completely designed, interchangeable products conform as exactly as possible to design, thereby distinguishing more clearly the responsibilities for product performance between design and manufacture. Many industries operate near the first of these extremes, a few near the second. Industry is shifting gradually toward the second extreme in which material is controlled and all physical, electrical, chemical, and appearance dimensions are stated.

In fixing these dimensions, the experienced designer knows he must consult with production engineers to insure that the design will fit, at reasonable costs, known processes or processes that can be developed. Also the designer has to arrive at some compromise with the production engineer as to the number of attributes that can be dimensioned. This co-operation between designer and production engineer becomes increasingly important in the early stages of design as the use of highly specialized machines increases.

Contributed by the Production Engineering Division and presented at the Semi-Annual Meeting, Los Angeles, Calif., June 28–July 2, 1953, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

If, after all dimensions have been met, the product performs improperly, it is more certain than before that responsibility is the designer's. If we are to charge him with responsibility, he must have the last word in specifying materials and dimensions, adequate research and development staff and facilities to determine what dimensions are required for the desired performance, and enough staff and facilities to prepare the volume of specifications and drawings needed for a complete job. Under good design specification practices, few questions concerning product performance remain in an uncertain zone among the designer, the manufacturer, and the user. Such expressions as "good commercial practice," "high quality," "running fits," "free from blemishes and defects," "good workmanship," and so on, appear less frequently in favor of clear-cut specifications. Few products have behind them perfection in this matter of isolating design responsibility, yet the possibility of defining it exists and the practice is growing.

RESPONSIBILITIES OF PRODUCTION ENGINEERS

The more clearly we define the responsibility of the product designer, the more clearly does the responsibility of the manufacturer stand out. First, he must understand the design, then he must accept the design as possible of manufacture. He must provide materials, facilities, and personnel that can make products which meet all requirements of the design. He must manufacture at lowest possible costs. He must ship only those products that meet design requirements. These prerequisites have a number or engineering aspects that can be readily identified. That the aspects shown in Table 2 are suitable problems for the engineering profession has common acceptance. This table simply expands the middle group of steps shown in the previous table.

Some manufacturers may find in the list responsibilities and activities which they think do not need engineers. The words "responsibilities" and "activities" are used somewhat interchangeably because they are so closely associated. Some manufacturers would place certain of the responsibilities in operating, or inspection, or personnel organizations.

From these responsibilities others are implied. For example, items 6 through 9 of Table 2 directly imply responsibility for the safety of methods and facilities. This requires experts in industrial hygiene and allows no sharing of responsibility for the safety of a process that has been specified unless there is misuse or abuse of materials and facilities. In the simplest terms, all fourteen items reduce to (*a*) design liaison, (*b*) prescription of manufacturing methods and processes, (*c*) provision of facilities, and (*d*) continuing cost reduction and development as the responsibilities of engineering for production.

ORGANIZATIONAL VALIDITY OF THIS GROUPING

A number of criteria for effective organization should be applied to this group of responsibilities before assuming that it should be administered as one organization or as several.

1 Do they have common interests? Their common interests are the product, the long-term value of plant provided, and the need for engineering treatment of the problems involved.

2 Does this grouping save confusion, conserve effort? At the risk of oversimplification, the assumption is made that, if the responsibilities of an organization can be stated simply in a way that clearly differentiates it from other organizations, elimination of confusion and of duplication of effort follow. The simple overriding statement of responsibility for design liaison, prescription of manufacturing methods and processes, provision of facilities and cost reduction and development in these fields seems reasonably free from misinterpretation and resulting confusion.

3 Can the organization's effectiveness be measured? The direct measures are the ability to find any way at all to make the product and then the quality and cost of the product when made in the way prescribed and with the facilities furnished.

4 Does a continuing need exist for the effectiveness of the organization? The need for an organization charged with the foregoing responsibilities depends upon a continuing input of challenging new product designs and continuing expansion of available manufacturing techniques. It does not depend upon the job conception and personality of one or a few individuals.

Of course, these criteria distinguish only production engineering from other manufacturing organizations. They do not guarantee that any random arrangement of production engineering's internal organization will be effective.

From this background, comes the conclusion that the need for a profession of production engineers stems primarily from the separation of product-design responsibilities from other responsibilities and from the demand for interchangeable, highly technical and exactly controlled products. The need for the profession stems only incidentally from the desire for lower cost. For the former need it is indispensable, for the latter it is desirable.

ORGANIZATION OF PRODUCTION-ENGINEERING EFFORT

To this point, the place and problems of the production-engineering organization in industry has been reviewed as background for discussing the internal arrangement of such an organization.

Several possible groupings of the activities listed in Table 2

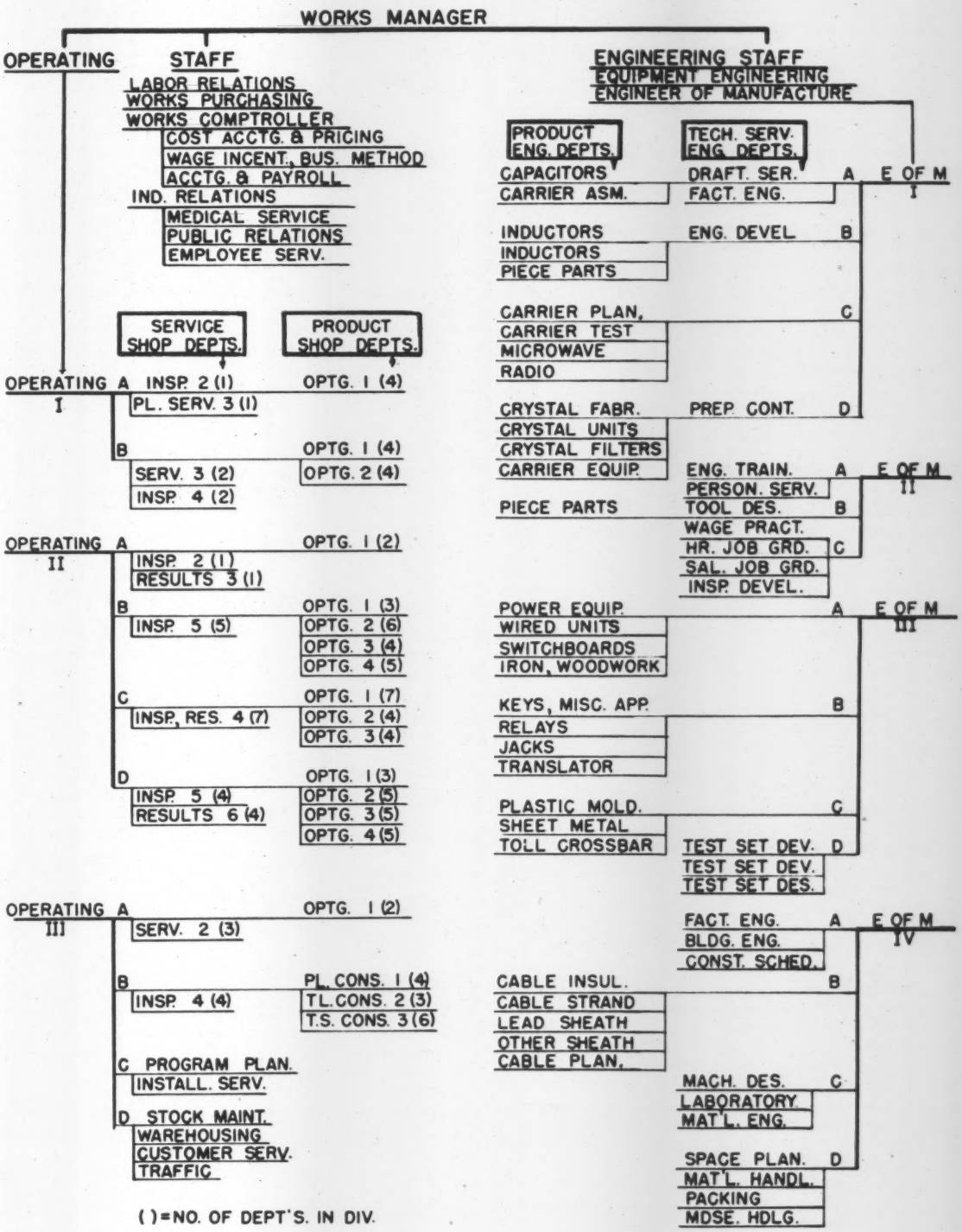
TABLE 2 RESPONSIBILITIES OF A PRODUCTION-ENGINEERING ORGANIZATION

1	Assistance to designers in development of product
2	Preparation of preliminary cost estimates
3	Continuing liaison with product designers
4	Interpretation and transmission of product design information to all manufacturing activities
5	Control of purchased material specifications
6	Designation of processes and detailed steps by which product is to be made
7	Development of new processes and methods when required
8	Determination of kind and amount of facilities required
9	Design and provision of facilities required
10	Development and designation of inspection methods
11	Rating of jobs as to personnel skills required
12	Shop assistance in manufacturing difficulties
13	Final estimates of costs of new products
14	Continuing cost reduction and development by suggesting product-design changes and by introducing better facilities, processes, and combinations of human skills

are apparent. The first four items center on the product design, understanding of its objectives, consultation with the product designer as to manufacturability and cost, and translation and subdivision of design requirements into shop language. Sometimes they require building models to assist the designer and to learn more about the design. Items 6, 7, 8, and 13 bear on how to make the product and the facilities required. The ninth activity emphasizes design of manufacturing facilities which may or may not be commonly found in industry. Items 7 and 14, development of new processes and methods and cost reduction, require ingenuity, considerable initiative, and development ability.

Perhaps the list could be organized around the four groupings just mentioned. Rather than speculate on that possibility or on many theoretical alternative groupings, one manufacturer's organization will be described and some of its features discussed; namely, the engineer of manufacture organization in the manufacturing division of the Western Electric Company, who makes most of the communications apparatus and equipment used by the Bell System. During the thirty years of the

TABLE 3 ORGANIZATION FOR MANUFACTURING ENGINEERING



organization's existence, various internal combinations have been tried but there has been little change in its responsibility to the remainder of the Manufacturing Division and the Company. Since the form of organization is substantially the same in all manufacturing locations, generalized Table 3 will be more informative than a chart showing specific products or all details of organization. Numerous other ways of arranging the work or of breaking the organization apart into a number of entirely separate organizations are possible. This one is presented and discussed because it is real and has been faced with many of the problems of production engineering.

Table 3 shows two kinds of engineering departments. The one that associates directly with a product-shop department is called a product-engineering department. The other that gives routine or technical consulting service to the first kind is called a technical or general service department.

FUNCTIONS OF PRODUCT-ENGINEERING DEPARTMENTS

In reading Table 3, it must be understood that each product-shop department looks to one product-engineering department for all the manufacturing-engineering services it requires. If the product-engineering department does not originate the information, instruction, or facility upon which a specific need for service is based, it must get, approve, and deliver them. The product engineer works with the product designer to insure that the product can be made consistently with high quality and reasonable cost. He accepts or rejects the manufacturing aspects of the product design for the Manufacturing Division and becomes headquarters for the manufacturing drawings and specifications of it. As the artist uses paint to express his idea, the product engineer has to work with human effort in the shop to express his ideas. Amounts of skill, kinds of skill, and implementation of skill must be selected and applied. He plans the co-ordination of human effort with tools, machines, power, and factories. He lays out and records for the shop each step of production from piece part through assembly, test, and inspection. These records are the basis for assigning labor grades, setting wage incentives, and establishing costs. He specifies the kind of material to be used for each part according to the designer's requirements, or according to standard practice, and states the amount of material required per part. He decides what tools and machines are to be used and provides the number required. The steps of production at which inspection is to be made and how the inspection is to be made are specified by his department. He determines how much space is to be provided for the shop, how it is to be arranged and equipped.

Manufacturing information flows all the time from the department. It applies to changes of design, tools and machines, alternative-material stocks, changed floor plans, inspection methods, increased or decreased quantities to be made, supplier difficulty, shop difficulties, better application or organization of operator skills, hazard reduction. The rate of flow of such information varies from time to time. A great number of small individual items flows steadily from the department through routine channels to many other organizations. Intermittently arise the large projects for which management looks to the product engineer and the technical staff for information and advice. Small and large, they total into a complete recorded foundation upon which management is based.

Once the large projects are approved, management gives the product engineer great technical and economic leeway. If the project requires intensive investigation over a long period, it may be organized as a development project which shifts to regular product-engineering treatment as processes become firmly established. The soundness of large projects rests to a great degree upon the foundation built in the handling of small items. A major project requires skill with economic studies, experience in introducing new parts and assemblies, and good judgment as to the time required to introduce them. Practice with a variety of manufacturing methods leads to quick selection of suitable processes and accurate appraisal of their economies and resultant product quality. Experience with former projects yields orderly transitions from one product to another and freedom from unexpected delays in product schedules. Experience in bringing all the specialized skills of a large organization to bear upon a project, encourages boldness and confidence in undertaking entirely new processes rather than patching up old methods.

Much of the success of the product engineer depends upon his ability to keep open avenues to the product designers, to a wide variety of manufacturing technologies, to his own related technical consultants, to the operating organizations, and to the accounting organization. His work is unsuccessful if he does not understand that manufacture of interchangeable, complex and high-quality products depends upon recorded, detailed instructions for each step in manufacture and that his control over these instructions greatly facilitates initiating changes.

Depending upon their magnitude, the plans and decisions of product engineers are subject to approvals by higher levels of supervision. If the decisions involve radically new practices or far-reaching changes, there will be numerous conferences with shop supervision to acquaint them with plans and to obtain the benefit of their experience and statement of needs before action is taken.

FUNCTIONS OF TECHNICAL SERVICE DEPARTMENTS

A single department of product engineers varying in size from five to twenty people cannot have experts in all the broad range of responsibilities given one Works Engineer of manufacture. Therefore, a number of other departments of a service nature or of technical-consultant caliber exist to provide general services or to concentrate specialized technical services where they may be available to all product engineers. Titles of the departments as they appear in Table 3 need little explanation. These departments of specialists are obligated to keep the product engineers informed of the best tools, machines, finishing methods, metal-joining practices, and general factory services available, and to design them as required. To insure this co-operation, all requisitions for manufacturing facilities, changes, and rearrangements must have two kinds of approvals, one for expenditure, the other for design. Expenditure approvals come from the product-engineering line of organization. Design approvals come from the specialists, such as the tool designers, test-set designers, standard machine-procurement department, factory engineers, and so on.

A less obvious feature of Table 3 is worth comment. A sharp line at higher levels of supervision between product engineering and technical consulting is undesirable. For that reason, both kinds of engineering are located in each superintendent's organization, sometimes in an assistant superintendent's. This balance between the two functions is important to the well-being of the organization.

Having established these two kinds of departments, lines for expansion and contraction of the organization are clear. Some movement of personnel between the two is desirable, especially for new engineers. Improved perspective of the human and technical aspects of production engineering results from a technical specialist going into product engineering and from a product engineer going, for example, into tool, machine, or test-set design or into factory engineering.

KINDS OF ENGINEERS REQUIRED

A broadly based engineering organization of the kind de-

(*Continued on page 793*)

High-Altitude and Speed PROPULSION WIND TUNNEL

At the Arnold Engineering Development Center, Tullahoma, Tenn.

By F. L. WATTENDORF,[1] J. NOYES,[2] AND A. I. PONOMAREFF[3]

INTRODUCTION

THE conquest of the air is a continuing struggle to broaden the margin between actual aircraft performance and the necessary minimum requirements. As plane speeds rise into the supersonic ranges, new requirements challenge our future progress in the development of propulsion systems and aerodynamic structures. These requirements must be fulfilled for continued leadership of United States air power. This is a challenge both to the mind of man and to his ability to provide the specialized facilities and equipment necessary to explore the fundamental phenomena associated with high altitudes and speeds.

Surveys conducted in Germany in 1945 by members of science and industry of the Allied Nations indicated that our aircraft industry did not compare favorably with the advanced state of German industry, especially in regard to wind tunnels for the study of aircraft performance in the supersonic regions. In 1946 the Scientific Advisory Board, under the chairmanship of Dr. Theodore von Kármán, recommended to the United States Air Force that surveys be made on the expansion of aeronautical test facilities in this country. After extensive studies had been made, the 81st Congress authorized the establishment of the Unitary Wind-Tunnel Plan in Public Law 415, which provided for test facilities at the NACA, universities, and the United States Air Force's Arnold Engineering Development Center. The initial test facilities at the AEDC are to be the engine test facility, the gas-dynamics facility, and the 16-ft × 16-ft propulsion wind tunnel, Fig. 1.

One principal function of this large propulsion wind tunnel will be to assist in the development and testing of completely integrated full-scale propulsion systems, minimizing the necessity for long and extremely expensive flight-test programs. Another function will be to resolve the future of the propeller for application to transonic aircraft.

This propulsion wind tunnel will increase the effectiveness of the Air Force operations by virtue of its unique ability to collect aeronautical data on specific aircraft and guided missiles, and thus insure that these weapons are functionally suitable to perform their design mission.

The recent action in Korea has proved that the power plants in present aircraft are not wholly satisfactory under some operating conditions. The ability to test the complete propulsion system under simulated conditions and thus segregate unpredictable losses in performance will permit improved design

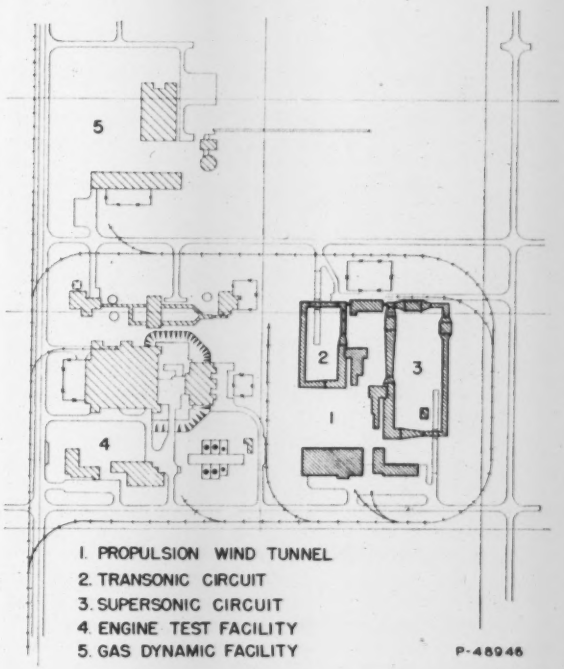


FIG. 1 PROPULSION WIND TUNNEL AND ASSOCIATED FACILITIES AT ARNOLD ENGINEERING DEVELOPMENT CENTER

of future weapons and assure our leadership in the further conquest of the air which is imperative for the national defense.

GENERAL

The propulsion wind tunnel is designed primarily to probe the internal-external aerodynamic characteristics of aircraft propulsion units, i.e., the ramjet and turbojet as installed in aircraft or missiles, and for aerodynamic testing of airframes or missile models. The facility is designed to provide testing conditions from a Mach number of 0.8 to 3.5 under simulated altitude conditions.

The propulsion wind tunnel is arranged in two basic closed-loop circuits, the transonic and the supersonic, with duct diameters ranging from 36 to 55 ft. The test sections in both loop circuits are 16 ft × 16 ft in cross section and 40 ft long. They are designed as a wheeled cart which may be disconnected from the tunnel circuit to facilitate the exchange of test models, minimizing tunnel shutdown time. Each circuit is complete with compressor, adjustable nozzle, test section, diffuser, cooling system, closed-circuit ducting, and necessary supporting elements. The drive system is common to both circuits,

[1] Technical Adviser, Aeronautical Research and Development, U. S. Air Force, Washington, D. C. Mem. ASME.

[2] Project Engineer, Sverdrup & Parcel, Inc., Consulting Engineers, St. Louis, Mo.

[3] Manager, Condenser Engineering Department, Steam Division, Westinghouse Electric Corporation, Lester, Pa. Mem. ASME.

Contributed by the Aviation and Gas Turbine Power Divisions and presented at the Semi-Annual Meeting, Los Angeles, Calif., June 28–July 2, 1953, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

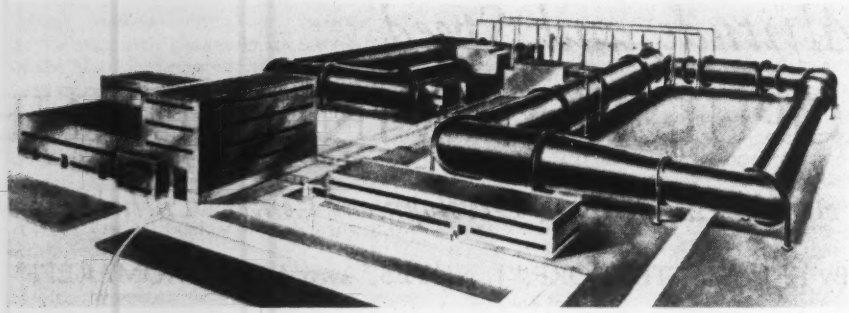


FIG. 2 GENERAL ARRANGEMENT OF TRANSONIC AND SUPERSONIC-TUNNEL CIRCUITS AND DRIVE SYSTEM

however, and totals 216,000 hp. The general arrangement is shown in Fig. 2.

Provisions have been made for removing the products of combustion from propulsion models by means of a scavenging system and replacing the contaminated air with dry "make-up" air. The equipment of the engine test facility is used for this purpose, as well as for the control of the pressure levels in the tunnel circuits for altitude simulation.

Suitable buildings have been provided to house the main motor drive, test control, model installation, and office personnel.

COMPRESSOR DRIVE SYSTEM AND CONTROL

Compressors for the transonic and supersonic-tunnel circuits are driven by a common system consisting of two 83,000-hp, 600-rpm synchronous motors and two 25,000-hp 10-pole wound-rotor induction motors. These four motors with a combined continuous power rating of 216,000 hp are arranged in tandem with disconnect couplings, permitting the operation of either compressor at full or partial loads on the motors. The two wound-rotor induction motors will be used to accelerate the compressors to the speed of the synchronous motors and then will be disconnected from the line until the power requirements exceed 166,000 hp, after which their power will be added to the drive system to reach an aggregate capacity of 216,000 hp. The wound-rotor motors will operate at the speed of the synchronous motors with some 17 per cent slip.

All motors are enclosed and provided with forced ventilation and a recirculating cooling system, including air-to-water coolers and blowers. Blowers for the wound-rotor motors will be located in the foundation pits, which will serve as plenum chambers for the air passing from the coolers into the blowers. The blowers will force the cold air into the motor at each end.

The compressor-drive system is provided with a mechanical brake to bring the entire unit to a standstill after it has been decelerated to a few rpm by means of d-c dynamic braking on the wound-rotor induction motors. The mechanical brake will be energized automatically at a predetermined low speed. The arrangement of the drive system, couplings, and brakes is shown in Fig. 3.

Two liquid rheostats are provided to control the speed of the 25,000-hp wound-rotor machines by varying the secondary resistance. Each rheostat is capable of a peak dissipation of 25,000 hp through its 36-in-diam electrodes. The liquid-rheostat assembly is of the cubical type with over-all dimensions of approximately 5 ft wide, 15 ft long, and 20 ft high. The cubicle is divided into an upper and lower compartment. The upper compartment contains a mechanism for moving the electrodes, and the lower compartment contains three electrolyte cells. Two pumps and three electrolyte-to-water heat exchangers are provided for each rheostat.

COMPRESSORS

The transonic and supersonic circuits of the propulsion wind tunnel are served by two independent axial-flow compressors. The three-stage compressor in the transonic circuit is designed to produce a Mach-number range from 0.8 to 1.6 in the transonic nozzle, with a volumetric flow in excess of 13,000,000 cfm at the inlet to the compressor. The extremely wide operating range of pressure ratio and volumetric flow required for the tunnel operation under fully simulated altitude conditions is obtained by means of compressor stator-blade control at a constant operating speed of 600 rpm. The compressor is designed to be capable of absorbing all the installed motor capacity of 216,000 hp.

The compressor consists of inlet guide vanes, three axial-flow stages, discharge guide vanes, and a diffuser. A disk-type compressor rotor consists of two stub shafts and three 18-ft-diam disks which are held in their relative position by two cylindrical spacers. The stub shafts, disks, and inner spacers are held together by through-bolts, forming one rigid integral assembly. The rotor is supported by two 26-in-diam $\times$ 34½-in. bearings located approximately 20 ft apart.

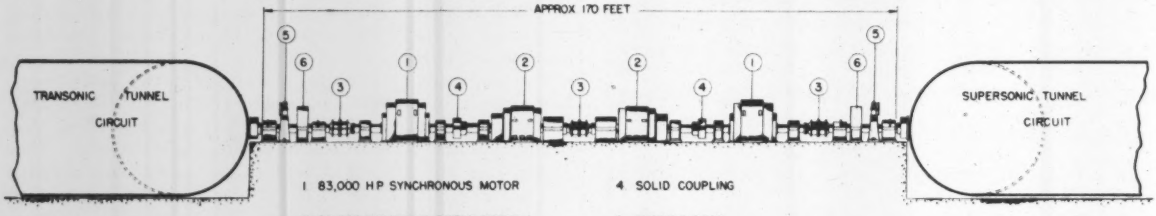


FIG. 3 MOTOR-DRIVE SYSTEM FOR PROPULSION WIND TUNNEL

Each of the 24-in-chord, 72-in-high compressor blades is secured to the rotor disk by three 3-in-diam pins. In the final design of the rotating blades, the distribution of blade thickness along its height and the disk profile were selected in such a way as to set their natural frequencies above the lower multiples of the compressor operating speed. While calculation methods for the simpler modes of vibrations of blades mounted on solid rotors or heavy disks have proved quite satisfactory, the complexity of the blade structure mounted on a relatively flexible disk have made calculations somewhat unreliable. Therefore a quarter-scale model of the compressor rotor was built, Fig. 4, and modes of disk and blade vibration were established through a wide range of speeds with the aid of strain gages and an optical system.[4]

The compressors for the supersonic-tunnel circuit are designed to produce a Mach number ranging from 1.4 to 3.5 at the test section with air flows from 7,000,000 to 13,000,000 cfm at the compressor inlet. This extremely wide operating range will be obtained by means of compressor stator-blade control. Fig. 5 shows blades being arranged for tests of blade-shifting mechanism. For this purpose, all stator blades are equipped with trunnions extending outside of the compressor casing. Each stator-blade trunnion is geared through a linkage to the operating motors which will be capable of changing blade orientation by some plus or minus 15 deg to meet various operating requirements in the tunnel. The stator blade-shifting mechanism is designed to change blade orientation while compressors are in operation.

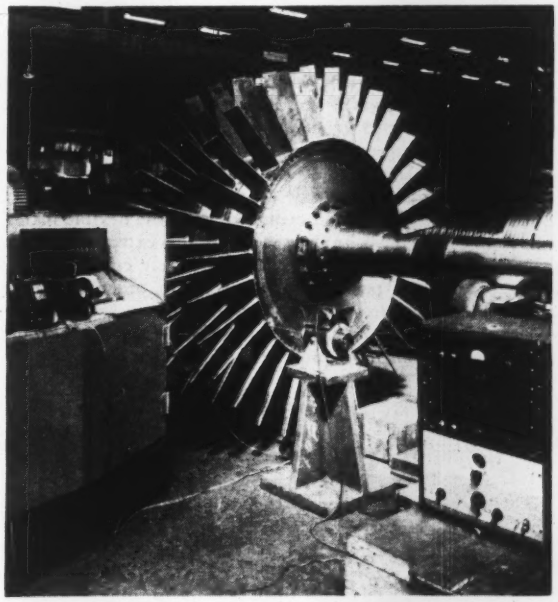


FIG. 4 QUARTER-SCALE MODEL OF ROTOR FOR TRANSONIC-TUNNEL COMPRESSOR STATIC VIBRATION TESTS

The 18-stage axial-flow compressor in the supersonic circuit is arranged in four separate units in series. The first three units are four-stage compressors and the fourth is a six-stage unit. This separation of the compressor into four units is dictated by the tunnel requirements for efficient operation over an extremely wide operating range of the pressure ratio. At high pressure ratio, all four compressor units will operate in series. For the operation at a lower pressure ratio, one, two, or three compressors may be disconnected to avoid large losses due to "windmilling" associated with the compressor operation at pressure ratio below that for which it is designed.

[4] "Mechanical Design and Testing of Long Steam-Turbine Blading," by H. M. Owens and W. E. Trumpler, Jr., ASME Paper No. 49—A-64.

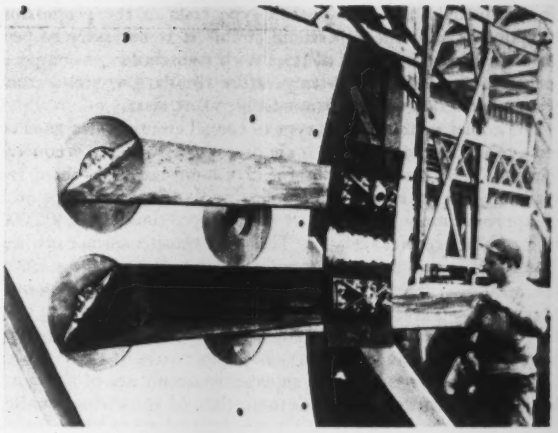


FIG. 5 COMPRESSOR-STATOR BLADES ARRANGED FOR TESTS OF BLADE-SHIFTING MECHANISM

Hydraulically operated flexible couplings are provided between each compressor to disconnect the last one, two, or three compressors. A 45-ft-ID by-pass duct over the last three compressor casings provides a flow path into the tunnel over the disconnected compressors. Hydraulically operated Iris valves are provided between each compressor to direct the air into the by-pass duct, thus preventing air from entering into the disconnected compressor and causing pressure loss. In a closed position these Iris valves will provide the normal air path into each compressor.

The rotating element of each compressor serving the supersonic-tunnel circuit is composed of 18-ft-diam forged disks, spacers, and stub shafts which are held by through-bolts in one rigid assembly. The rotor blades, which range in height from 58 to 18 in., are attached to the disks by pins. Each compressor rotor is supported by two 26-in-diam × $34^1/_2$-in. bearings. The bearings are supported by two struts spaced 75 deg apart. These are water-cooled to prevent bearing misalignment caused by the thermal expansion of the tunnel-compressor structure. The aerodynamic thrust of the compressors is carried by four self-aligning shoe-type bearings designed for a total thrust capacity of 2,500,000 lb. The thrust bearings are arranged in pairs, each being supported on a common thrust bridge which, in turn, is connected to the tunnel structure through the thrust ties.

The fixed anchor point for the supersonic-tunnel circuit and compressors is located at the low-pressure compressor. The movement of the compressors and the by-pass shell is limited to the axial direction by guides on the vertical center line of each compressor. The compressor stators are supported at each end by a stator-support ring which rests upon two radial spherical-ended columns passing to the foundation mat through a sealed opening in the by-pass shell.

COOLING SYSTEMS

The transonic circuit has a single cooler, which is downstream from the compressor. The supersonic circuit contains two coolers, one upstream from the compressor and one downstream. In the transonic circuit it is possible with one cooler system to perform both the altitude-temperature-simulation tests, and constant-temperature tests. The latter will be uti-

lized primarily for aerodynamic-type tests of the propulsion components. In the supersonic circuit it is necessary to perform the foregoing types of tests with two coolers, a compressor precooler for altitude-temperature simulation, and a compressor aftercooler for constant-temperature tests.

The cooler system in this type of tunnel circuit is designed to remove all the energy of the main drive system, which is equivalent to 45,000 tons of cooling at maximum rating of the drive system. The transonic aftercooler involves a cooler face area of approximately 10,000 sq ft with approximately 1,500,000 sq ft of heat-transfer surface. This heat-transfer surface utilizes aluminum-finned tubes arranged six rows deep. These tubes are arranged in bundles which are mounted in a horizontal herringbone pattern in the 55-ft-diam-tunnel circuit. This arrangement reduces the maximum total pressure drop to approximately $^3/_4$ psi.

The cooler systems in the supersonic circuit are of the same basic arrangement as the transonic, but of somewhat smaller size. The supersonic-circuit aftercooler utilizes tube materials which are capable of high-temperature operation, since they must be able to withstand temperatures during altitude-temperature-simulation tests up to 650 F without circulation of the cooling water.

These cooler systems are designed to function under a wide variety of flow conditions. The air flow will vary from 500 to 20,000 lb per sec. The temperature drop across the coolers will vary from 20 deg F to 100 deg F in the transonic circuit, and from 40 deg F to 600 deg F in the supersonic circuit.

The cooling system is supplied with cooling water at an average temperature of 72 F with quantities ranging from 10,000 gpm to 100,000 gpm. The wide range of operating conditions imposed on the coolers will be accomplished either by varying the water rate, water circulation through one half of the rows of tubes, through water recirculation, or through the combination of these methods.

SCAVENGING AND MAKE-UP-AIR SYSTEMS

The products of combustion from the model exhausts are to be removed from the tunnel circuits in order that combustion models may be operated for continuous periods without contaminating the main-tunnel air. The equipment of the engine test facility will be utilized for both the scavenging and make-up-air services. The multiple compressors and exhausters may be arranged to supply air and remove gas up to approximately 500 lb per sec. This includes the weight flow of a large amount of tunnel air, which must be removed to prevent contamination

The exhauster system has sufficient capacity and pressure ratio to allow scavenging of combustion-engine exhaust up to an altitude of 100,000 ft. The air introduced in the circuit must be reasonably dry in order to prevent the maleficence of moisture condensation in the test section. The rates of scavenging and make-up-air weight flows are controlled to maintain steady pressure levels in the tunnel circuit.

NOZZLE SYSTEM

Both tunnel circuits contain a Laval nozzle of the flexible-plate type. A Laval nozzle comprises essentially a subsonic-contraction zone, a throat section, and a supersonic-expansion zone. The tunnel flow progresses downstream from the 55-ft-diam stilling chamber through the low-speed three-dimensional contraction zone into the subsonic two-dimensional rectangular contraction, through the throat where the flow reaches sonic velocity, and then accelerates through the supersonic expansion zone to the desired Mach number at the entrance to the test section.

The flexible portions of this nozzle consist of vertical side walls, whose contours are positioned accurately by screw jacks located at several stations. These flexible plates are essentially of a constant thickness. The top and bottom walls are parallel and flat. The position of the flexible plates is controlled by in-and-out movement of the screw jacks and it is, therefore, possible to match the required contours for any Mach number throughout the range of the nozzle design. The transonic nozzle will be designed to operate from a Mach-number range of 0.8 to 1.6. The supersonic nozzle will be designed for a Mach-number range of 1.4 to 3.5.

Each of the transonic-nozzle flexible plates is 16 ft wide × 58 ft long. The design and manufacture of the flexible plates, their surfaces, and positioning jacks require extreme accuracy since the flow through the nozzle is extremely critical. Wall ordinates must be positioned accurately in order to obtain smooth and shock-free flow in the test section. The design of the supersonic nozzle is complicated further by the high temperatures required for propulsion-simulation testing.

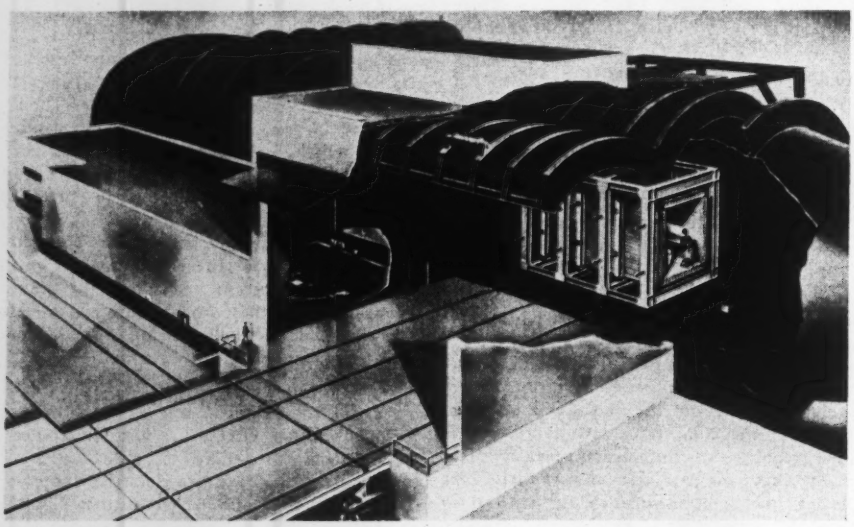


FIG. 6 WHEELED-CART TEST SECTION, SHOWING TUNNEL HATCH OPEN FOR REMOVAL OF CART

TEST SECTIONS

The test section of each circuit is designed as a wheeled cart, as shown in Fig. 6. This cart will contain a model mounted on its supports, including the model balance and measuring systems. Each cart, weighing over 300 tons, may be disconnected from the tunnel circuit, wheeled out through a large hatch in the tunnel shell onto a transfer car. The test-section cart on the transfer car then may be rolled to the model-installation building (MIB), where changes may be made to the model, its support systems, or a new model may be installed. During this process, another test model in a second cart may be rolled and installed in the tunnel circuit.

The test-section carts are designed so that they may be mounted interchangeably in either the transonic or supersonic circuits. The use of two test-section circuits in the propulsion wind tunnel and the ability to interchange test-section carts, will permit extreme flexibility, minimizing costly time delays involved in exchange of models.

Provisions have been made in the MIB to allow cart modification in one of the building bays, which is serviced by a large-overhead-crane system. Sufficient space has been provided in the MIB to allow installation of models in four carts at the same time. It is planned ultimately to provide cart test stands where model installations, particularly combustion models, may be checked out in a static condition prior to being installed in the tunnel circuits.

Each tunnel circuit is provided with a test-control building, which is immediately adjacent to the test area of each circuit. These control buildings will contain the required control boards, instrumentation, and auxiliary equipment necessary to support the operation of the test models during test runs.

INSTRUMENTATION AND CONTROLS

The main basic categories for tunnel control comprise compressor and main-drive system, cooling system, pressure-level-control, nozzle-control, model-control, and safety-control systems. In addition to the instrumentation associated with the foregoing control systems, instrumentation will be provided for tunnel and model systems. The model instrumentation comprises the model-supporting and measuring systems, the test-section flow-measuring instrumentation, and necessary data-measuring instrumentation. In most of the cases the model data will be fed into automatic recording, plotting, and data-reduction stations. Tunnel instrumentation will be provided to measure and record flow conditions at the compressor, cooler, and related portions of the tunnel circuit.

An instrumentation shop will be furnished within the facility to allow normal routine maintenance on instrumentation and to make provisions for installations required by the varied-type models to be tested.

SPECIAL DESIGN STUDIES

Design problems associated with the propulsion wind tunnel have involved special problems of an aerodynamic, thermodynamic, mechanical, and structural nature, which have required special treatment. The research facilities of United Aircraft Corporation, Cornell Aeronautical Laboratory, Georgia Institute of Technology, University of Minnesota, Ohio State University, Purdue University, University of Texas, and research and development facilities of the Westinghouse Electric Corporation have been used on problems involved in this project. Valuable information also has been obtained from existing wind tunnels, particularly those operated by the NACA. The results of the tests and studies in the various agencies have been utilized to crystallize geometries, shapes, and sizes, all of which were necessary in order that the design of this facility could be based on sound economical principles consistent with the best engineering practice.

ACKNOWLEDGMENT

Permission by the United States Air Force to publish information concerning the propulsion wind tunnel of the Arnold Engineering Development Center and its facilities is gratefully acknowledged.

Organization for Production Engineering

(Continued from page 788)

scribed demands many kinds of people. In the terms of conventional training, people having bachelor degrees in mechanical and electrical engineering are needed in the largest numbers. Then come chemical engineers, metallurgists, civil engineers, wood technologists, and a number of others. The product engineers must comprehend the product thoroughly. They must be able to discuss all phases of it with the designer, helping him by design suggestions and manufacturing means to achieve a suitable product. A distinction, difficult for many students really to understand, is that these engineers do not have the responsibility for designing the product; but rather that they have the responsibility for designing the processes, methods, and manufacturing facilities and procedures.

This responsibility gives wide range for mechanical design ability in providing intricate tools, machines, and handling equipment to implement plans of production prepared by product engineers. In the electrical field, test-set engineers must design circuits for electrical and mechanical measurements such that the variability of test sets when operated continuously by unskilled personnel is only a small fraction of that permissible in the product. Some engineers are needed to design and keep modern the water, compressed air, power, plumbing, ventilation, lighting, and other services that are critical to the operation of a large factory. A supporting force of clerks, draftsmen, model builders, and laboratory technicians is needed to take many routine matters off the shoulders of the engineers. One ability that is required of all product engineers and some of the technical-service engineers, is the ability to assemble reliable, comprehensive, economic data and to prepare sound recommendations from them. All this must be done with realization of effects upon the design of the product and upon large numbers of individuals ranging from those who make the product to those who use it.

MEANS FOR PRODUCTION-ENGINEERING EFFECTIVENESS

As well chosen, as well grouped, and as well manned as any organization of activities as that described may be, it is of little value unless it has the support of the other organizations in the enterprise. Informal acceptance and support by the other organizations must be based upon recognition that, in their field, the production engineers are experts. Formal support of the effectiveness of production engineers comes first from giving their instructions for manufacturing processes the force not of suggestions but of requirements of shop production, and second from assigning to production engineers control of expenditures for all new or changed manufacturing facilities. Although the first gives control over manufacturing processes and methods on the basis of assigned authority, it has little value without the second. Without responsibility for expenditures for plant facilities, the best of engineering plans, the most careful of economic studies, and the most active cost-reduction program are paper work.

When the production-engineering organization has to make a reality of its planning by providing the facilities it has specified and then the actual qualities and costs are compared with quality and cost estimates, a measure of the effectiveness of organization for production-engineering is possible.

Machining of HIGH-TENSILE-STRENGTH STEEL

By F. M. RAYBURN

ASSISTANT TOOL DEPARTMENT MANAGER, MENASCO MANUFACTURING COMPANY, BURBANK, CALIF.

THIS paper describes the routine procedures used by the author's company to machine high-tensile-strength steel. Reference is made to the experience gained in low-production operations on steel of 280,000 psi tensile strength and machining of titanium specimens.

TYPE OF MANUFACTURING INVOLVED

The author's company is engaged exclusively in the manufacture of aircraft landing gear and has been manufacturing this product for 12 years.

Material. During this period there has been a constant increase in the demands placed upon aircraft landing gear. The aircraft industry continually must seek means of saving weight without sacrificing safety and performance. The result has been a corresponding increase in the tensile strength of the steel used in the major components of landing gear.

To the fabricator of the landing gear, the significant consideration is the increased hardness which is associated with this increase in tensile strength.

During the early phases of World War II, 4140 steel was used at tensile strengths ranging between 160,000 and 190,000 psi. This is associated with a hardness of 36 to 42 Rockwell C. At that time, this material was considered to be quite difficult to machine.

By the end of World War II, 4340 steel was being used in addition to 4140. The tensile strengths required had risen to a range of 180,000 to 200,000 psi and the hardness which resulted was from 40 to 44 Rockwell C.

Since 1948, 4340 steel with tensile strengths from 200,000 to 220,000 psi has become the rule in company production. The hardness is from 44 to 46 Rockwell C. With the exception of the final topic, this discussion will deal entirely with the machining of steel of this description.

Parts. One of the most common sources of difficulty in the manufacture of landing gear is the shape of the parts. It is realized, of course, that this type of problem is not unique but it does seem to be characteristic of this product. The reason for this probably lies in the secondary position held by landing gear in aircraft design. Since the landing gear contributes nothing but weight to the air-borne characteristics of the craft, it must be subordinate to structures which are vital to the flying function.

This situation inevitably leads to oddly shaped parts. It makes it necessary, furthermore, to remove metal wherever possible. As a result, the fabricator is required to make cuts at points which ordinarily would be considered inaccessible. The use of oddly shaped and inefficient tools is unavoidable. The toolholders cannot be held within the precepts of good design. The fixtures required are likely to interfere with tool application and frequently cannot be made sufficiently rigid to permit the desired operation rates. The eccentric masses presented by these parts make slower spindle speeds mandatory.

These conditions make the matter of tolerances more difficult. While the tolerances allowed might not seem exceptionally close, they offer something of a problem when remote areas are being machined. This, and all of the foregoing items, are accentuated by the hardness of metal being machined.

Quantities. In general, aircraft landing gears are not ordered in sufficient quantities to permit full application of production-line principles. Most setups must be made repeatedly and so must not be too time-consuming. This, furthermore, leads to inconsistent tool performance.

MACHINE TOOLS—CUTTING TOOLS

As would be expected, the higher-tensile-strength steels make greater demands on the machines. Those machines with the greatest rigidity and power should be used for these operations.

Older lathes should be strengthened at all vital stress points. In general, newer lathes seem to be heavy enough to do a satisfactory job. The author's company has recognized the increased power requirements by specifying that all new lathes must be powered at about 30 per cent above the catalog power rating. This has proved to be satisfactory for the present requirements.

It would have been desirable to have followed a similar procedure with milling machines. At the present time the application of carbide tools is limited because of the low surface-feet per minute rates available. More power would be necessary if the rates were to be increased.

Grades. Although the company makes extensive use of both carbide and high-speed tools, the carbide types are used whenever their requirements can be met. The carbide tools were first introduced in company production in 1939, and have become increasingly important as the steels being worked have become harder.

The various grades of carbides, which are available, give excellent performance in all situations which do not require a combination of shock resistance and abrasion resistance. It is possible to obtain grades of carbide which will offer either excellent shock resistance or excellent abrasion resistance. The difficulty lies in obtaining both of these characteristics in the same tool.

Unfortunately, jobs which produce both shock and abrasion are quite common. Lathes are used frequently to make interrupted cuts, and repeated engagements of the cutting edge are the nature of milling. Although there are grades of carbide which are indicated for this situation, they do not solve the problem. It appears that the combination of abrasion resistance and shock resistance has not yet been accomplished without a loss in effectiveness of one characteristic or the other.

In view of the superiority of carbide-tool performance, under conditions producing only shock or only abrasion, it would seem to be possible to produce a tool of equal superiority in the

Contributed by the Research Committee on Metal Processing and cosponsored by the Production Engineering Division and presented at the Semi-Annual Meeting, Los Angeles, Calif., June 28–July 2, 1953, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

NOTE: Statements and opinions advanced in papers are to be understood as individual expressions of their authors and not those of the Society. Manuscript received at ASME Headquarters, April 8, 1953.

intermediate category. Such a development would be most welcome to manufacturers who machine high-tensile-strength steel.

When high-tensile-strength steel is encountered, it becomes apparent that the grades of carbide tools are not standardized. Softer steels permit the tools made by various manufacturers to be interchanged without a noticeable change in performance. With the harder steels, however, the slight variations between so-called "equivalent" grades become significant. It is felt that a re-evaluation and standardization of the carbide-tool grades would be a valuable service to the tool consumers.

Brazed tips have proved to be satisfactory. Most of the cuts made in this plant do not require the strength of the clamped tips, and the brazed tips cost considerably less. In principle, brazed tips are not as desirable due to the different expansion rates of the metals which are brazed together. In practice, however, only a few isolated operations have been found to justify the cost of the clamped bits.

High-speed steel has had important applications in meeting certain tool requirements. Nearly all of the form tools used by the company are made of high-speed steel. The inserted tips of milling cutters are almost exclusively made of high-speed steel.

Typical Cutting-Tool Problems. It is required that a boss and face, of small diameter, be turned on the end of a part 25 in. long. Although a high finish, close tolerances, and a twice-interrupted cut are necessary, the problem arises as a result of the hardness of the metal. Two factors were probably equally responsible for the solution of this problem. (*a*) the AR-12 carbide bit was ground with a negative top rake of 10 deg and a 45-deg angle across the point; (*b*) a tool jack was employed to gain the necessary rigidity.

It is required to turn a diameter at a point which causes four interruptions of the cut per revolution. The first efforts employed the grade of carbide recommended for such cuts on this type of steel. A negative top rake was used once more to meet the shock of the interrupted cuts. It was possible with this arrangement to produce but one or two parts per grind. Strangely enough, substitution of a softer and tougher grade of carbide with a 6-deg positive rake increased wear life of the tool three times. General tool applications are given in Table 1.

TABLE 1 TOOL APPLICATIONS

Operation	Tool description	Remarks
Turning:		
Continuous	Carbide with chip breaker	
Interrupted	Carbide with negative top rake	
Boring:		
Stock removal	Spade drills, and blade reamers of M3-Type 2 HS steel	
Finish cuts	Carbide bits	
Angles, radii, and chamfers	Carbide or high speed	Choice dependent on specific application
Threading:		
Engine lathe	Brazed carbide	Combined tool and holder must present maximum rigidity
Thread lathe	Solid carbide	Rigidity of machine usually adequate
Slab-milling	Molybdenum, high-vanadium high-speed-steel inserted tips	Climb milling and carbide tips preferred
Form-milling	Solid high-speed steel as above	Form relief is critical factor
End-milling	Solid and tipped carbide inserts	Fly-cutting
Drilling and reaming	Molybdenum-tungsten HS steel	Best possible point lubrication is needed
Taps	Same as drills and reamers; heat-treated to 65 Rockwell C	Con-eccentric grinding of root diameter and crest relief. Precede with similar tap slightly undersize

MACHINING OTHER HIGH-TENSILE-STRENGTH METALS

4340 Steel With Tensile Strength of 260,000 to 280,000 Psi. This material has been worked only under low-production conditions but the methods employed undoubtedly will lend themselves to regular production when required. In spite of the fact that most machining operations are being carried out successfully on this type of steel, every effort is made to do as much of the machining as possible before high heat-treating is done. Alternation of machining and heat-treating operations has proved satisfactory. At the present time, the parts are rough-machined, normalized, heat-treated to 160,000 to 180,000 psi tensile strength, further machined, heat-treated to 260,000 to 280,000 psi tensile strength and then finish-machined.

Distortion from heat-treating is controlled by the use of fixtures during this operation. Metal removal required to correct distortion ranges between 0.005 and 0.020 in. This is a distinct advantage with metal as hard as this. The total metal left for finish cuts is approximately 0.060 in.

Thread-tapping and drilling of wire holes and grease holes necessarily have been done before heat-treating. Holes tend to shrink during the heat-treat operation and so are retapped when indicated. Holes greater than $^3/_{32}$ in. have been drilled successfully, after heat-treating, with drills of molybdenum-tungsten high-speed steel, but carbide-tipped drills are used more generally.

Threading with single-point tools was successful after heat-treating. This was possible even through keyways and slots so long as the corners were chamfered.

Decarburization is controlled by exclusive use of salt baths in heat-treating. Although the results have been satisfactory, the specifications for these parts require that all heat-treated surfaces be machined afterward. Grinding is not acceptable because it produces sufficient heat to create surface stresses. As an alternative process the author's company has resorted to a form of hypermilling.

A burr of sintered carbide has been used as the cutter and the results have been quite satisfactory. It has been used on an inside diameter only but will be applied generally in the future. The finish attained was a 25 microfinish as indicated by a profilometer. Virtually no heat was produced in the part although chips were blackened.

Honing has had application in the finishing of long bores after the finish-boring operation.

The heat-treated metal was cut successfully with circular milling cutters as large as 6 in. in diam. Larger radii happen to have been made with fly cutters.

End-milling was done with solid and tipped carbide. This was satisfactory so long as the surface-feet per minute rate could be maintained.

Machining of Specimens of Titanium Alloy. The shop facilities of the author's company have been called upon to shape approximately 40 pieces of forged titanium alloy, to suit the purposes of metallurgical laboratories, both company and other. The specimens were 90 per cent titanium, 5 per cent aluminum, 3 per cent chromium, and 0.2 per cent carbon. Their hardness in a non-heat-treated state was 40 to 42 Rockwell C. In spite of this relatively high degree of hardness, the toughness is the outstanding characteristic of the metal.

(*Continued on page 798*)

EXPLORERS *and* CREATORS

By L. A. DuBRIDGE

PRESIDENT, CALIFORNIA INSTITUTE OF TECHNOLOGY, PASADENA, CALIF

A NUMBER of years ago Dr. A. A. Noyes, in formulating the educational policies for the newly reorganized California Institute of Technology, enunciated the following proposition:

"The undergraduate course in engineering shall be of a general fundamental character with a minimum of specialization in the separate branches of engineering. It shall include an unusually thorough training in the fundamental sciences of physics, chemistry, and mathematics and a large proportion of cultural studies; the time for this being secured by eliminating some of the more specialized subjects commonly included in undergraduate engineering courses....It is hoped in this way to provide a combination of fundamental scientific training with a broad human outlook—avoiding narrowness on the one hand and, on the other, superficiality and lack of purpose...."

Needless to say I subscribe heartily to this statement which has been the "credo" of Caltech for the past 32 years. On the basis of this policy the California Institute has turned out some fairly creditable scientists and engineers! It has also turned out men who have risen to positions of responsibility, influence, and leadership in science, engineering, and industry, as well as in community and national life. In an individual, in a university, in a company; in a community, and in a nation we need knowledge and competence of many types; we need breadth of vision, we need not only intelligence but wisdom; not only intellectual but also moral leadership.

That is my philosophy and I want to lay it on the table at the outset, for I do not want to be misunderstood in the things I am about to say. I don't want anyone to dismiss the remarks which follow by saying "Oh, he is just a scientist; he doesn't understand the finer things of life."

That very statement, in fact, is as good a place to take off as any. Who is it that thinks he has a monopoly on the "finer things of life"? Who says that the poems of Omar Khayyam are any "finer" than Newton's Laws of Motion? I'll take my "loaf of bread" and "jug of wine" along with the next fellow. But I'll deny they are any "finer" than the elliptical orbit of the planet Mercury, and far less grand than Einstein's Theory of Relativity. I am quite willing to use the terms beautiful, noble, majestic in speaking of the plays of Shakespeare, the paintings of Rubens, the music of Brahms. But I claim the right to use the same terms in describing the great scientific achievements of Newton, of Darwin, of Einstein, and of Bohr.

But my friends the humanists say "no." Art, music, and literature are beautiful; science and engineering are crass, materialistic, earthy, practical. And besides they are too technical! Then comes the punch line. It goes like this: "Furthermore," they say, "science is the cause of all the world's troubles. If we only had less science and more literature, or art, or music, or religion, or something, the world's troubles would all be cured."

I believe firmly that statements of this sort, even though widely repeated and believed, are sheer nonsense. And it is time that scientists and engineers pointed out the nonsense in no uncertain terms.

In designating the nonsense it is not necessary to make any derogatory remarks about any nonscientific area of human endeavor. It is no reflection on Brahms' music to see beauty in other things too. It should not offend those who receive inspiration from art and literature to suggest that others receive just as true and fine an inspirational experience from astronomy or physics.

I happen to believe that knowledge, truth, and beauty are to be found by traveling down many avenues. Most people cannot travel more than one avenue at a time (though a few do). We should, however, neither envy nor disdain those who have chosen other approaches from the one we prefer.

Nor do I think it is possible to say that one avenue is better or finer or more useful or more valuable than another. Any particular human mind and spirit must seek to fulfill its dreams in its own way. Civilization as a whole needs the knowledge, the inspiration, the material products of all lines of effort, of all kinds of people. Physicist and poet, engineer and artist, astronomer and historian, biologist and economist—all men who seek knowledge, truth, beauty, understanding are adding in equal measure to the welfare of men.

Nor do these men work independently. The social scientist cannot hope to see his ideals of a more effective and peaceful social structure come to pass without the tools provided by medicine, public health, science, and industry. Nor is the engineer very effective or useful in a social organization which is unable to provide rudimentary civic orderliness, to say nothing of economic resources. Nor do men live happily, even with physical comforts and social and political stability, if they do not have also access to beauty, inspiration, love.

In short, men, individually and collectively, need intellectual *and* spiritual advancement. We should all encourage all paths which lead to this end.

In this total picture the scientist and engineer have a vital part to play. They can play that part effectively only if the true nature of their rôle is understood—first by scientists and engineers themselves—and secondly by the public at large.

What is the role of the scientist and the engineer? To make radios, automobiles, bathtubs, deep freezers, jet airplanes, and atomic bombs? Well, I regret to say, to hear many scientists and engineers talk you would think that's all they are good for. We have bragged so much about the gadgets we have produced that people are getting a little tired of hearing about them. Even our fellow Americans in other pursuits have caught the fever and brag to the world about American gadgets—implying a rather noticeable disdain for other nations that have fewer gadgets to display.

But do we ever stop to raise the question as to whether the inhabitants of other countries even want the gadgets of which we are so proud? The Hindus of India, I understand, do not want bathtubs. They believe it is unclean to sit in water that has been already soiled. (Personally I agree with them!) They are understandably rather mystified therefore when we brag about how many bathtubs we have.

Again there are many people whose standards of *values* differ from ours. They may want certain things but not at the price

---

Address at banquet, June 30, during the Semi-Annual Meeting, Los Angeles, Calif., June 28–July 2, 1953, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

they would have to pay. I mean not only the price in dollars but in the way of living. A Chinese peasant on his farm might not care to work in a factory even at a very handsome monetary wage. I have even heard residents of Southern California wonder whether the smog is not too high a price to pay for the industrial community we have created. I know many people who wish that no one else would drive a car! I am quite convinced that many a resident of Europe is glad that his highways are not as choked as ours. Is not each group of people entitled to its own wants and tastes?—its own collection of things it does not want?

And so, what is the scientist and engineer for? To turn out endless supplies of things, no matter how much they clutter up the place or how much smoke and dirt they produce or cause, how much they cost?

I claim it is time to call a halt to our continuing oratory about our wonderful gadgets. We need to ask what these gadgets are for and how they came into being. Most of all we should shed our egotistical assumption that because we like certain gadgets that people on other continents are deprived of, they do not long for them also.

So now I can give my version of what scientists and engineers are for.

Let us start with a scientist.

I begin by asserting that curiosity is one of the most sublime of human attributes. I shall always have a grudge against the man who invented the assertion that "curiosity killed a cat." That phrase has been a menace to the advancement of learning for generations. I personally don't believe it is true. I'll bet the cat was killed either looking for food or for another cat. More likely the phrase was invented as an outright lie by an impatient parent seeking to terminate a torrent of questions from an alert 10-year-old boy. What a tragedy it is that such boys have been so treated by parents and teachers that by the time they are 18 the natural tendency to ask questions has been thoroughly drilled out of them!

Yet I insist that man as an intelligent human being moves forward intellectually and spiritually solely because some men keep on asking questions all their lives. Some men have a divine curiosity which no one can destroy—and the sum total of human knowledge consists of the answers those men have found to the questions they have asked. Down through the ages scholars have asked many questions about many things. They have found many answers; some were right, others turned out to be wrong. But in the process man's knowledge and understanding steadily grew.

Those scholars who ask questions of *nature*, questions about the physical world, and who then seek nature's answers, are called scientists. Some ask questions about the sun, moon, and stars, others about the structure of the earth. Some inquire about the behavior of living things, others about the nature of matter. All are seeking knowledge, seeking to understand.

One man climbs to the top of Mt. Everest—because Everest is there and he wishes to conquer it. A scientist performs experiments with atoms, because atoms are there and he wishes to understand them. Both men are impelled by a basic human urge. The urge to explore, to conquer is closely akin to the urge to know, to understand.

That is what scientists are for—to enlarge man's understanding of the physical world.

Why enlarge it? Simply because men are so built that they will never rest until they do understand, until they do conquer their ignorance and satisfy their sublime curiosity.

Yes, I am familiar with the argument that knowledge has practical value too—it enables men to keep warm, to prevent hunger, to make money. But tonight it is my thesis that the conquest of ignorance is good for its own sake, good because it satisfies man's intellectual and spiritual desires. And all men everywhere, as they learn to appreciate art and music and literature, should learn also to appreciate, to understand, and to promote the work of the scholar and the scientist as they continue their quest for knowledge.

And how about the engineer? What is he good for? Is he the one whose job it is to make things, to design gadgets, to build structures? Is it true that while the scientist seeks truth the engineer seeks cash?

Sadly enough many people, including many engineers, think of it in just that way. Naturally we are all proud of the things engineers have created. It is not unnatural that we brag about them. But just what do we brag about? As I have already said, bragging to a Hindu about a bathtub leaves him wholly mystified. And this leads me to state a rule we too often forget: A gadget is not something that is good (or bad) for its own sake; it is something that is good (or bad) only to the extent that it satisfies an important human want, an important human need, an important human desire.

For example, men need a certain minimum amount of food each day. Therefore devices or techniques which enable them to produce more food, to produce it more economically and to transport it to where it is most needed, quickly and economically, are things to brag about. But they are worth bragging about not because they are cute or ingenious or because they make the inventor a lot of money, but because they save human lives, reduce human suffering, enable human beings to devote energy to things other than the sheer satisfaction of hunger. Similarly with things that keep men warm when the weather is cold, or cool when the weather is warm, dry when it rains, and so on; these things satisfy basic human needs.

Down through the ages the job of the technologist, the engineer, the applied scientist, has been to develop methods of satisfying human needs.

Now, when a device is invented which does satisfy such a need, the people who have the need will work to acquire the device. They will pay for it. Hence somebody makes some money. And there is nothing wrong about that either. But it is wrong to put the importance of the medium of exchange through which a need is met above the importance of the need itself. We will be doing a favor to everyone if in our own thinking and in our public statements we express the engineers' contributions to society in terms of human needs rather than solely in terms of American dollars. This will have also the advantage that we will examine the real needs of people in this and other countries and the price they would have to pay to fulfill them before we criticize them for not using the things that we invent.

Now, as all of us are only too-well aware, there may arise periods in the history of any country when it must resort to force of arms to defend its independence or to preserve its very existence. Patriotic citizens of that country will use their talents and energies to assist their country to carry on the fight successfully. And so it will come about that scientists and engineers of the country will abandon their normal peacetime pursuits and turn their attention to devising weapons and techniques of warfare. No one disputes the great success these endeavors have achieved in recent years.

This is fine, and scientists and engineers can be proud of the results of their work. But it has all added another difficulty to our problem of public relations and public understanding. For now the scientist and engineer are often looked upon not as a patriotic citizen who helped preserve his country's freedom but as a diabolical inventor of weapons of death. Again the existence of the thing has overshadowed the purpose for which the thing was developed, the human need which it was designed to meet. The scientist and engineer (I must continue now to

use both terms because, in times of crisis, scientists become engineers, temporarily, in order to help get a job done), instead of being regarded as the protectors of human freedom, are looked upon as the agents of destruction. "Science has outrun human relations," it is said. What does that mean? Actually, science and engineering are our best instruments to promote human understanding. They are instruments to protect human freedom. They are instruments to satisfy man's wants and needs, to advance his welfare. The major objective of scientists and engineers is to make the world a better place in which to live. I somehow wish those words could be engraved in a place where all men could see them—especially those fearful men who, seeing the products of science and engineering, hysterically call for a stop to further invention lest evil men use those products for unintended purposes. Evil men there will always be. But they will not be curbed by asking good men to stop thinking!

Science and technology have become so important a part of the structure of modern American civilization that, like air and water, we have come to take them for granted and even ignore their intrinsic value. In the old days the public could ignore science and technology, for these activities were independent of public attention. The scientist would continue his work in the laboratory no matter what the taxpayer thought. The engineer also went about his business, unconcerned about government activities and policies.

A depression and World War II have changed that. All citizens are daily more affected by government than they used to be. This is especially true of scientists and engineers. This is true in the first place because a large share of the nation's scientists and engineers turned their attention to war work during the war, thus bringing about a profound change in direction of the nation's technology. A large fraction of them are still at work on problems connected with war technology. Many others work in areas which were opened up or given a new turn through war developments. These developments created new demands—new needs for scientific and engineering effort. All of these things together greatly increased the need for scientists and engineers. The supply has also increased, though never as fast as the need. Thus there are far more scientists and engineers than ever before, spending far more money than ever before. A far larger fraction of them are working directly on government activities. Those still in private business are more dependent on government orders, or at least on government tax policies. The support of research in pure and applied science has been to a substantial extent assumed by government.

Now I am not trying to argue whether the present situation is right or wrong, sound or unsound. All I say is that it exists. And since it is also manifestly true that our nation needs science and engineering more than ever before, it is desperately important that taxpayers and voters understand more than ever the true role of the technical man.

If the taxpayer thinks of the scientist solely as a maker of weapons of war, he will expect him miraculously to appear when weapons are called for and conveniently to disappear from the tax bills when new weapons seem slightly less urgent. The taxpayer will not be happy, however if he finds that technologists in other nations have invented cleverer weapons than ours. And he will be impatient with any excuses such as "our funds were inadequate," "our equipment was obsolete," "not enough trained scientists could be found." The taxpayer wants things delivered on demand.

So far the taxpayer has nothing to complain about. He has received high dividends on a modest investment. But the temptation to kill the goose is still strong. He forgets that golden eggs came, not because they were ordered, but because there was a goose. The task of our nation today is not solely to order science and technology to deliver certain weapons. It is to maintain a healthy science and technology. Weapons will then come when needed—and all the other things men will want and need will come besides.

The maintenance of a healthy science and technology is largely a matter for the private citizens and private companies, universities, and foundations to provide. But the government stake is so great that the government cannot shirk its responsibility. There is grave danger right now, for example, that a substantial fraction of the scientific research and development going on in nongovernment laboratories will be stopped within a year. When budgets are being cut it is only human nature that urgent, obvious, short-range activities will be cut the least, thus insuring that longer-range activities will be cut the most. Scientific research—whatever its ultimate value—does not usually pay off within the fiscal year. Thus certain government agencies, such as the Office of Naval Research, which have carried a large share of the load of supporting research activities are being faced with the possible necessity of 30 or 40 per cent cuts. A disruption in research projects would thus take place which years of future effort could not restore. Even from a very practical standpoint this is bad economics. From the standpoint of the long-term welfare and security of the nation it is disastrous.

In this particular emergency it may be necessary for all of us once more to call public attention to the dollar value of science and engineering. But if we confine our attention to this issue we shall only be meeting a series of future similar emergencies. For it is a paradoxical fact that in the long run people will not continue to spend money for things whose sole value is a dollar value. We don't very long spend dollars to buy dollars—we spend dollars to satisfy needs, to fulfill desires, to make dreams come true. The explorers and creators of the laboratory are doing more than creating material wealth; they are bringing the stars to earth, and lifting men to the stars.

Machining High-Tensile-Strength Steel

(*Continued from page 795*)

Machinability is complicated by the surprising ease with which titanium work-hardens. Sandblasting and power hacksawing will produce this result. Cutoff and scale removal, however, are accomplished easily in a lathe. Turning, drilling, and boring are difficult with the grain.

Carbide tools of abrasion-resistant grades should be used. They should be "razor" sharp and diamond-honed if possible. Drills must be of the oilhole type if the hole is to exceed 3 in. in depth.

Carbide-tipped drills and chrome-plated high-speed drills work equally well so long as they are ground with a single cutting lip. Flat high-speed-steel drill blades and twist drills with a full radius work well to a depth of 5 in.

Titanium requires greater tool pressure than steel and yet is subject to indentation if a tool of less than 0.030 in. radius is used in a lathe operation. Evidence of this grain disturbance can be detected 0.050 in. below the surface of such a cut. The exact depth of the effect is dependent upon pressure and sharpness of the tool, type of coolant, and possibly other factors.

The standard clearance angles used for turning, boring, and reaming steel were generally satisfactory. Straight lead angles were not successful. Large radii (0.030 to 0.250) proved more successful.

An attempt was made to anneal this material but the resultant hardness was the original hardness of 40 to 42 Rockwell C. The operation seemed to result in an increased toughness, although there was no attempt to measure this characteristic.

ENGINEERING MODE *of* ANALYSIS

By G. A. HAWKINS[1] and L. M. K. BOELTER[2]

As a result of the recent technical developments and the expansion of scientific and engineering knowledge, the analysis and synthesis of engineering structures, circuits, processes, and machines are becoming ever more complex. The designing engineer of tomorrow in solving his problems will need to use complicated analytical and experimental procedures, models, and analogs each requiring an ever-increasing knowledge of mathematics, physics, chemistry, and the basic engineering subjects.

The professional engineer engages in the design of new structures, machines, circuits, or processes and predicts their behavior and cost under given conditions, and studies existing engineering systems and modifications thereof and forecasts their performance and cost under specified operating requirements. A study of the procedures used by these engineers indicates that in general they employ the same method or mode of analysis. It is felt that we need to re-emphasize this general mode of analysis. Before considering the specific details of the general mode of analysis it is desirable to review the concepts of the actual and the ideal systems.

ACTUAL AND IDEAL SYSTEMS

Owing to the complexity of present-day engineering machines, structures, processes, and circuits, it is difficult, and in many instances impossible, to study them without introducing simplifying statements. In order to consider an actual engineering system the engineer must devise an ideal or mental concept based on certain simplifying assumptions, which he then studies in place of the actual device. As a final step in the consideration of the system, the engineer must predict the behavior of the real or actual system from the results obtained from his ideal or mind system. This latter step requires a great deal of actual experience, which is usually acquired after graduation. Because of the limited time and other factors it is only possible to impress upon the undergraduate engineering student the importance of postgraduate experience with various engineering systems.

In order to illustrate the use of the ideal or mind system for the prediction of the behavior of the actual system, imagine that an engineer has been called upon to estimate the elongation of a vertical structural-steel bar when acted upon by a given tensile force. Before the engineer is able to apply fundamental laws or basic facts he must establish an ideal system based on definitions such as the following: The tensile force is applied along the exact longitudinal axis of the bar; no bending of the bar occurs; the bar material is homogeneous; the thermal environment surrounding the bar remains constant; all elemental fibers of the bar undergo the same elongation; the proportional limit of the materials in the bar is not exceeded; the weight of the material is negligible in comparison to the load. The components of the definition of the ideal system are often designated as assumptions, thus linking them with the actual system.

Having established an ideal system, the engineer is in a position to apply Hooke's experimental law and predict the elongation of the ideal bar. Based on previous experiences with other actual systems, the engineer then decides how accurately the elongation of the ideal bar will represent that for an actual rod.

The majority of experienced engineers establish the ideal system on the basis of simplifying assumptions with little ado. They become so accustomed to dealing with the idealized case they seldom think of it as a separate step in the procedures of analysis or synthesis.

PROCEDURES FOR STUDYING BEHAVIOR OF ENGINEERING SYSTEMS

Having reviewed the concept of the ideal and actual systems it is possible to consider how the ideal or mind picture fits into the general procedures used by engineers in the study of complicated engineering systems. It is felt that these six steps are generally used by engineers in the study of engineering systems:

1 The preparation of a complete statement of the problem associated with the actual system.

2 The establishment of an ideal or mind system based on (*a*) direct observations or a familiarity with the actual system; (*b*) direct observations or a familiarity with similar ideal or actual systems.

3 Specification of the boundaries of the ideal or mind system.

4 Application of the fundamental laws or basic knowledge in order to obtain the behavior of the ideal or mind system.

5 The prediction of the behavior of the actual system from the results obtained on the ideal or mind system.

6 The study of additional ideal systems if greater accuracy is required in predicting the behavior of the actual.

The results obtained using the first ideal system may not be sufficient in extent or have the desired accuracy in order to predict the behavior of the actual system. In this event a second mind or ideal system must be formulated and analyzed on the basis of other definitions. As the number of mind systems is increased, the behavior of the actual system may be portrayed more accurately from the analysis of the ideal cases. From a theoretical standpoint, if the number of mind systems becomes infinite, the behavior of the actual and ideal systems becomes one and the same. The number of ideal systems which an engineer may wish to use will depend upon such factors as economic limitations, available time, the knowledge of the engineer, and the knowledge of society, in general.

The general mode of analysis becomes unique to engineering when the solutions are evaluated in terms of time, cost, materials, and men. For example, during war periods, time and men may be more significant than cost or materials—hence the engineer must give serious consideration to these factors in his analysis.

SPECIFIC MODES OF ANALYSIS

Specific names may be used to describe the general method of study by referring to the laws and knowledge employed in the fourth step. If basic economic laws are applied, in particular a "cost" balance, then the method could be termed the economic mode of analysis. The mode of analysis used by engineers in the study of the static and dynamic behavior of a structure might be termed the "engineering-mechanics method of analysis," and probably would encompass the application of the following fundamentals in step 4: (*a*) The law of conservation of mass; (*b*) Newton's law of motion; (*c*) the law of conservation of energy.

[1] Dean of Engineering, Purdue University, Lafayette, Ind. Mem. ASME.

[2] Dean of Engineering, University of California, Los Angeles, Calif. Fellow ASME.

APPROACHES USED IN GENERAL MODE OF PROBLEM SOLUTION

There appear to be four general approaches used by engineers to complete the several steps of the general or specific mode of analysis. The four procedures are briefly described as follows:

Analytical. The analytical approach consists of applying and solving mathematical equations based on physical laws. By employing suitable techniques and computing facilities, satisfactory solutions for the equations may be obtained for use in predicting the behavior of some engineering system.

Experimental. This approach covers experimental determination and prediction of the behavior of the engineering system.

Art. In many problems encountered by the professional engineer the force fields may be very extensive or even unknown, and hence they cannot be treated analytically or experimentally. In these instances the knowledge of the engineer, which may be based on scientific training and greatly amplified by practical experiences, enables him to predict the behavior of an actual system. The professional engineer is able to sense the variables involved, which cannot be analyzed or formulated by the scientist who lacks his experience. Usually the engineer has available a large amount of unformulated knowledge gained by experiences with many actual systems upon which he may draw. This knowledge is sometimes translated verbally and pictorially but not symbolically, nor can it be generalized.

Models. This approach consists of establishing a model which may be used to predict the behavior of the actual system. In many instances the model method is used in conjunction with the experimental and analytical methods.

In the study of many engineering problems it is often necessary to use a combination of two or more of the methods in order to predict the behavior of the actual system. The ability to use the four methods independently or in combinations greatly expands the engineer's skill to predict the behavior of an actual from that of an ideal system.

Too often young engineers acquire a feeling that one of the four methods is superior and more important than all of the others. It is our responsibility as practicing engineers to help and encourage the young engineers in training to become proficient in the use of the four methods. In so doing we will enhance their education and strengthen the profession.

METHOD OF MODELS

In general, engineers are less familiar with the use of models than with the other three approaches. A model will be considered as a device used to predict the behavior of an actual system known as the prototype. The types of models used may be considered as divided into the following groups: True models, distorted models, adequate models, and analogs.

True models of this class are so constructed that all significant characteristics of the actual engineering system are reproduced to scale. The model must satisfy all other imposed restrictions as well as being geometrically similar to the prototype. The scale is constant; hence all measurements on the model correspond to the dimensions of the prototype. As an example, it was found impractical to design a locomotive frame of sufficient rigidity to maintain satisfactory alignment of the rotating parts in a turbine-electric power unit. As a result, an internally rigid, self-contained power unit was to be designed to be supported on the locomotive frame at three points. The complexity of the structure made theoretical analysis of the deflections most difficult. Hence a $\frac{1}{4}$-scale plastic model was made, loaded, and the deflections observed. A check of the model test data was later obtained by comparing the results of similar loading conditions upon an actual unit. In this instance the model analysis enabled the engineers effectively and quickly to increase the stiffness of the system with a minimum addition of weight.

In order to investigate all possible means for dissipating the flue gases from chimneys or stacks effectively an extensive model study was made prior to formulating the final design of a large steam-electric generating station. Models of the proposed buildings were constructed of wood. Brass tubes were used for the miniature stacks. Ammonium chloride was used to produce smoke to simulate the flue gases flowing from the actual chimney of the power plant. The models were located on a turntable in a wind tunnel. Valuable information and data were obtained regarding the influence of such variables as stack height, orientation of the building, wind velocity, and flue-gas velocity on the dissipation of gases from the stacks.

An adequate model is one which may be employed to predict one particular characteristic of an actual engineering system. While a true model will have only one length scale, a distorted model may have more than one scale. Models used for the study of the flow of water in river channels are often constructed using a smaller scale for the depth than for the width and length. The determination of the stresses and deflection in large steel frames of buildings which result from distribution of the wind pressure is very complicated owing to factors such as the breaking up of the air currents by surrounding structures. A model was employed successfully to study the deflections produced by wind forces on the Empire State Building. Important engineering design data regarding earthquake resistance of elevated water tanks have been acquired by use of models. Experiments were conducted during which earthquake motions were simulated and applied to suitable three-dimensional scale models. The importance of the use of models to study flow of fluids has long been recognized by those interested in aerodynamics, fluid mechanics, and heat transfer.

A distorted model is one in which it is necessary to violate a design condition to such an extent that a correction factor must be applied to the results in order to predict the behavior of the prototype. Studies have been carried out in the laboratories to determine the stresses in various types of pressure vessels. Plastic models have been subjected to fluid pressure and the internal stresses frozen in the plastic. By removing strips from the wall of the model and employing photoelastic techniques, important information has been acquired.

Analogs are units which do not resemble the prototype, but which obey an equation or equations identical in form to that which governs the prototype. By imposing corresponding initial and boundary conditions, the results obtained on the analog may be converted to represent corresponding results for the actual system.

The importance of the use of analogs for the analysis of engineering problems is recognized by many professional engineers. The analog constitutes a tool which is extremely useful, and all engineers in training should become acquainted with it.

The thermal-electrical analogy is based upon the similarity of the equations describing thermal and electrical phenomena, namely, the comparison of the partial differential equation for temperature distribution in a solid produced by the transmission of heat to the partial differential equation for the distribution of electric potential produced by a current flowing through a slender noninduction wire, and the comparison of the equations for the rate at which thermal energy is stored and for the rate of flow of charge into a capacitor.

CONCLUSIONS

The material presented will aid the young engineer to develop an appreciation for the general mode of analysis and

(*Continued on page 808*)

BEARINGS, LUBRICANTS, *and* LUBRICATION

A Digest of 1952 Literature[1,2]

JOURNAL BEARINGS AND BEARING MATERIALS

CONSIDERABLE attention has been devoted to the hydrostatic bearing, in which the pressure enabling the oil film to carry load is furnished from an external source. Higgins (1)[3] describes the application of this principle to the radial and thrust bearings of pumps, pointing out that this type of bearing permits the use of any material for the bearing and any fluid for the lubricant. Potts (2) describes the application of hydrostatic bearings to dynamometers. Theoretical friction at zero relative speed is zero, and Potts reports an observed friction coefficient of 7.5×10^{-7}.

Advances continue in the field of hydrodynamic journal bearings. Charnes, Osterle, and Saibel (3) discuss the energy relations in the lubricant film with particular reference to temperature rise. Archibald (4) calculates how the Rayleigh stepped-film design may be applied to journal bearings, the principal differences from the thrust bearing being the curvature and variable film thickness except when the shaft is centered at no load. In a careful experimental study, McKee (5) finds that oil flow from plain bearings is separable into two components, one a function of oil-feed pressure, and one a function of the hydrodynamic oil-film pressure. In bearings with circumferential oil-feed grooves, the hydrodynamic effect was small. Boyd and Raimondi (6) summarize much worth-while information from the literature in a form suitable for bearing calculations, and indicate methods of solution for problems of several types. A particularly well-rounded discussion by Klemencic (7) shows how the design engineer can employ current bearing theory to arrive at optimum designs. Boyd and Raimondi (8) analyze the performance of the pivoted-pad journal bearing and point out that while it is extremely useful in preventing whip at light loads, it does not exhibit lower deflection under load than a plain journal bearing. Studies of the effects of misalignment by DuBois, Mabie, and Ocvirk (9) show that large displacements of the oil-film pressure profile occur under relatively small misaligning couples, the maximum pressure shifting close to one end of the bearing. Rylander (10) found that particles of such materials as graphite, red rouge, and corundum in the oil supply to a bearing increase the friction coefficient, wear, and operating temperature, and change the oil-flow characteristics. Carter (11) describes an electrical-analog method for obtaining solutions to Reynolds equation. The National Bureau of Standards (12) has developed mutual-inductance gages for measuring shaft position in bearings.

The problem of oil whip continues to receive attention. Poritsky (13) introduces the concept of a force at right angles to the shaft displacement vector and finds that it results in the criterion that whip occurs at speeds double or more its natural frequency. Hagg and Warner (14) as the result of analog-computer studies find that regions of whip are defined by curves on a dimensionless plot of N^2C/g versus Sommerfeld number. Dayton, Simons, and Fend (15) attempt to deduce the reasons for experimental finding of some load capacity under cyclic loading when the load frequency is one half the shaft frequency; theoretically, the load capacity is zero under these conditions.

With the object of developing better materials for precision-grinder spindle bearings, comparative data were obtained by Kozacka, et al., (16) on cemented tungsten carbide and drill rod in an Almen machine. With kerosene as a lubricant the carbide was superior; extreme-pressure additives can be used to increase the load-carrying capacity of the bearing. Warring (17) discusses the use of resin plastics in reciprocating engines, where they are successful if not exposed to excessive temperatures. Friction is slightly higher than with metal bearings. Instrument bearing and pivot design are described in detail by Tagg and Howell (18); they also outline the method of manufacturing sapphire jewels for bearings. Jaffee and Weiss (19) report that indium is effective in eliminating corrosion in aircraft bearings.

A symposium on bearing fatigue provides considerable information on this type of failure. Etchells (20) reviewed the advantages and disadvantages of various alloy bearings having in mind fatigue strength, corrosion, and score resistance and deformability. Palsulich (21) describes types of fatigue failure and the effects of design and operating conditions for this failure. Carmichael and Purdy (22) point out that, although fatigue failures are not directly influenced by the lubricant, certain characteristics of the lubricant such as insufficient corrosion prevention, ability to seal against contaminants, and low film strength may permit such failures. Roach and Johnson (23) explored the theory underlying bearing fatigue and concluded that Poisson's ratio is an important property of a bearing facing in this connection. Although few reliable data are available on the ratios for bearing metals, certain assumptions indicate that the theory is in qualitative agreement with the results of laboratory tests and service experience.

BALL AND ROLLER BEARINGS

Macks and Nemeth (24), using a 75-mm-bore cylindrical roller bearing, have measured the cooling effectiveness of the oil supply by means of single and multiple jets. In another paper the same authors with Anderson (25) reported measurements on the effect of viscosity on cooling effectiveness in the same bearing. Lundberg and Palmgren (26) present equations for calculating the dynamic capacity of a roller bearing. This capacity is used to calculate the life of the bearing under various loads. Kendall (27) discussed the noise and vibration of ball-bearing spindles from the standpoint of a designer acting in the role of trouble shooter. Many symptoms are given to aid

---

[1] Report prepared by Dr. J. C. Geniesse and H. A. Hartung with the assistance of the ASME Research Committee on Lubrication. Contributing Committee members are: W. E. Campbell, J. C. Geniesse, M. D. Hersey, C. M. Larson, S. J. Needs, M. C. Shaw, S. K. Talley, and D. F. Wilcock. The summary for the year 1952 was based on the Engineering Index references on Bearings and Lubrication.

[2] Similar Digests were prepared for 1950 (MECHANICAL ENGINEERING, vol. 73, 1951, pp. 892–896), and 1951 (MECHANICAL ENGINEERING, vol. 74, 1952, pp. 885–891).

[3] Numbers in parentheses refer to the Bibliography at the end of the paper.

in identifying the causes of such difficulties. Johnson, Swikert, and Bisson (28) discussed the wear and friction properties of several potential cage materials for use in high-speed ball bearings. Cast iron and nodular iron were found to give the lowest wear rates when dry and the highest load capacities when lubricated, due to the protection offered by the graphite layer that forms on the surfaces during service. Brass, beryllium, copper, and aluminum were found to be poor materials for use as bearing cages, while Monel metal and nichrome V appeared to form protective oxide films that rendered them useful as long as such films remained on the surface. The small amount of lubricant that is really necessary for the successful operation of a ball bearing is illustrated by Wilcock (29). Lubrication studies by Brophy and Romans (30) with air-driven and electrically driven gyroscopes indicate that lubricants of lower volatility and better storage life are needed. Abnormally short rotor-bearing life is at least partly due to inferior replacement bearings, poor overhaul techniques, and careless handling at repair facilities.

Papers by Sternberg and Rosenthal (31) and Smith and Liu (32) considered the stresses associated with elastically loaded spheres. The Sternberg and Rosenthal paper presents an exact solution for the stress distribution in an elastic sphere when loaded at opposite ends of a diameter by concentrated loads. While these results may be of value in connection with stresses arising in ball-bearing balls, most bearings are found to fail initially on the raceways rather than on the ball surfaces. The Smith and Liu paper discusses the magnitude and location of the maximum shear stress in a plate that is loaded by a sphere. The normal load is supplemented in this investigation by a tangential force corresponding to a coefficient of friction of $^1/_3$; this causes the maximum shear stress to occur at the surface rather than below the surface (i.e., at 0.78 times the half-diameter of the contact area) and at the same time causes an increase of 43 per cent in the maximum shear stress of the Hertz analysis.

THRUST BEARINGS

Studies of a new mathematical approach to the solution of the Reynolds equation for slider-bearing lubrication, assuming an exponential variation of film thickness, are continued by Charnes, Saibel, Osterle, and Ying. Five additional cases have been considered; these are as follows: The viscosity a function of the pressure (33); effect of transverse curvature (34); effect of temperature on the viscosity (35); the sector thrust bearing (36); and the parallel-surface slider-bearing without side leakage (37). Results obtained are in good agreement with available previous studies.

Investigations made to determine the load-carrying ability of water-lubricated, tapered-land, carbon thrust bearings are reported by Levinsohn and Reynolds (38). Nine different bearings having various combinations of radial and circumferential tapers were tested. The degree of taper had a pronounced effect on performance. One bearing was able to carry a load of 110 psi (present limit of the test machine) at speeds of 860, 1725, and 3450 rpm.

Recent developments in thrust bearings for vertical hydroelectric generators are discussed by A. B. Lakey (39). Descriptions of the three main types, adjustable, equalizing, and spherical, are given in some detail.

Results of experimental studies on the behavior of a large vertical thrust bearing (in French) are given by Casacci and Peuchmaur (40). Measurements were made of starting friction, oil-film thickness, and variation of temperature in the oil film. The paper also contains an interesting bibliography on measurements of oil-film thickness and bearing temperature.

The "flow thrust bearing" is described (in German) and analyzed by G. Heinrich (41). The thrust load is carried by two rigid surfaces separated by high-pressure oil introduced at some intermediate diameter and escaping radially at the outside diameter in the case of step bearings and at both inside and outside diameters in the case of annular thrust bearings. The bearing surfaces are parallel and continuous; hence no oil wedges are developed. Oil is supplied by tubes of small diameter located so as to require minimum power from the oil pump. Effects of laminar and turbulent flow in the oil lines are considered.

Starting and running friction, oil-film thickness and oil circulation in vertical thrust bearings for hydroelectric generators are discussed (in French) by J. Chappuis (42). This short paper shows a cross section of a typical combined thrust and guide bearing and photographs of an actual installation. Elastic supports of the thrust-bearing shoes, to approximate equal shoe loading, are described.

Measurements of friction in disks under conditions of pure rolling and pure sliding have been carried out by A. Cameron (43). These experiments show that it is possible to develop an oil film under conditions of pure sliding with no rolling at all. Classical lubrication theory will not explain this new effect. The explanation advanced for it is that the variation of viscosity across the thickness of the film introduces an extra term into the classical hydrodynamic equation of film lubrication. Making two simplifying assumptions for the temperature of the surfaces in contact and the temperature distribution in the oil film, the theory is tested numerically.

AUTOMOTIVE LUBRICANTS

Pilger (44) reports fleet tests under heavy-duty, light-duty, and high-speed service conditions. Using engine cleanliness rating as a criterion, superior results were shown with detergent motor oils. Other factors such as the gasoline and base petroleum oil also affect final ratings. Fleet and controlled engine tests described by Edgar (45) show that high-detergency motor oils prevent oil-ring plugging and reduce cylinder-wall and ring wear. These effects extend engine-overhaul life which is generally based on the number of miles to reach excessive oil consumption. Spindt and Wolfe (46) find that high-additive-content oils reduce piston varnish effectively. They also report removal of some of the fuel-formed varnish previously deposited on the piston when the engine was lubricated with a nonadditive oil. Gadebusch, Karr, and Bassett (47) comment on the difficulty of filtering detergent oils to a light color. While these oils reduce engine deposits, the suspended sludge goes through normal filters. Incipient sludge formation on the filter is an indication that the detergent is practically exhausted.

Extensive tests with engines and planes in Alaska and in cold rooms are described by Barron (48). It was found that satisfactory lubrication may be obtained with controlled gasoline dilution of the engine oil. Related lubrication problems such as foaming, icing, oil spewing, and drainage have been solved through mechanical means. In other experiments with full-scale aircraft, Harris, et al., (49) indicate that oil temperatures can be allowed to run higher without adverse effect on engine life. This decreases engine-friction loss and airplane drag due to the oil cooler.

Brooks and Atkin (50) measured by electrical conductance the effect of ring geometry on lubrication between piston ring and cylinder wall of a single-cylinder aircraft engine. Square and torsion rings with tapered faces and chamfered edges were evaluated under various operating conditions. Two piston-ring designs which might be expected to give improved performance were suggested. Latest developments in piston rings

are described by Braendel (51) as taper-faced rings for quick seating and resistance to scuffing, torsional rings for blow-by seal, filled rings for two-cycle engines, and antiscuff coatings for wear reduction. Chrome-plated rings prevent scuffing but they are not quick-seating. Oil rings must be conformable in order to control oil consumption.

Electron micrographs at magnifications of 6750 to 45,000 were used by McBrian (52) to show that detergents are not in true solution. Experience with diesel engines proves that a finely dispersed detergent is advantageous. Hence photographs which show the degree of dispersity will indicate the condition of the lubricating oil. Sennstrom (53), with the aid of the spectroscope and railway diesel-engine tests, determined the maximum amounts of metals in lubricating-oil ash for the control of maintenance. Unusual liner, ring, or bearing wear may be detected from the chromium, iron, and copper content of the used oil. Pagliassotti and Porsche (54) describe a simple rapid spectrographic method for the direct determination of phosphorus, barium, calcium, and zinc in lubricating oils. The procedure is suitable for plant control.

GEAR LUBRICATION

Blok (55) offers a thoroughly modern discussion of the gear lubricant as a gear-constructional material. Considering, first, oil-supply problems, he presents a photograph of oil trajectories starting at the tips of the teeth. He investigates friction losses incident to expulsion of oil from tooth gaps, and churning losses; and gives formulas for the mean film thickness retained before tooth meshing. He discusses the optimum temperature for most efficient operation. Turning to load-capacity problems, he shows theoretically the beneficial effects of elastic deformation, especially when the lubricant has a high-pressure coefficient of viscosity. He emphasizes the effect of pressure-viscosity in concentrating the film pressure into a narrower zone, but holds that the film pressure cannot exceed the Hertz pressure for dry contact. Blok concludes that high-performance gears operate with part of the load carried by a fluid film and part by a boundary film conforming to his flash-temperature hypothesis. Under this hypothesis scoring or scuffing occurs when the film reaches a critical temperature, regardless of speed or tooth pressure.

Heidebroek (56) reports experiments conducted at Dresden to clarify the influence of the oil film on gear-tooth frictional phenomena. He shows how the amplitude of friction fluctuations increases with time, and with various surface conditions pointing to the existence of relatively stiff adsorbed boundary films. In discussing the kinematics of tooth contact, he introduces diagrams to show the relative movement of every point on one tooth profile, with respect to the mating tooth surface. He concludes that much basic research remains to be performed, before a true insight into the laws of friction and lubrication of gear teeth can be gained.

Kolarik, Zeiler, and Kipp (57) report that the Timken machine tests for load capacity of straight mineral oils, both the OK and psi values, are appreciably increased in going to higher-viscosity grades at constant speed. From diagrams given, it would appear that the rate of increase is not far from proportional to the square root of the viscosity at a standard temperature. There is a similar increase with speed for a given oil. Thus, in judging the effects of additives, care must be taken to choose lubricants of equal nominal viscosity, and to compare them at the same speed. In the discussion it was brought out that there is a similar viscosity effect in other types of EP lubricant bench test.

The Institute of Petroleum held a Symposium on Gear Lubrication; Part I, Lubrication of Gears, comprised the seven papers reviewed in the following:

Cameron (58) compared hydrodynamic theory with experimental results showing qualitative agreement with a new disk tester, but requiring further development of the theory to allow for elastic deformation, and for temperature distribution in the oil film, and over the tooth face (see also reference 43).

Finch and Spurr (59) discussed gear-tooth wear as affected by the relative degree of rolling and sliding motion. The temperature rise is governed by the velocity of sliding at any point. Protection by EP lubricants requires formation of a surface layer whose melting point is low enough to provide lubricating action below the softening temperature of the metal surfaces.

Barwell and Milne (60) advocated improvements in gear design so as to prevent scuffing by means of fluid-film lubrication. The action of EP lubricants may be due in part to low coefficients of friction at high temperatures. The beneficial effect of a slight roughening of the tooth surfaces, hitherto attributed to the formation of miniature oil reservoirs, may, in fact, be due to the interruption of heat flashes before too high temperatures are reached.

Mansion (61) described the IAE gear-lubricant-testing machine in which two pairs of gears are loaded torsionally, one against the other. Tests on straight mineral oils showed that the higher the viscosity grade the less the scuffing. This was attributed to the larger hydrocarbon molecules, since equivalent changes in viscosity brought about by a change of temperature had much less effect. Additives increased the scuff load about threefold. Nitrided steel gave the highest scuffing load of the gear materials tested. Chemical surface treatments and electroplating were beneficial. Scuffing failures were unaffected by change of oil jet from ingoing to outgoing side.

McEwen (62) reviewed the mathematical theories including high-pressure viscosity. He distinguished between fluid-film lubrication, where failures may occur from pitting due to fatigue, and boundary lubrication, where surface failures are caused by scuffing which results from breakdown of the lubricant. He discussed the effect of roughness on the film thickness required for hydrodynamic lubrication, and also the effect of the relative radius of curvature.

The beneficial effects of colloidal graphite were reported by E. A. Smith (63) as shown both by the Timken machine and by worm-gear tests. A comparison was made with the effects of sulphur, mica, and dichlorethyl ether, both on weight loss and load capacity.

A careful study of the respective mechanisms of wear and of pitting was reported by Evans and Tourret (64). Their findings were based mainly on the Thornton disk machine. Both internal and surface cracks lead to pitting. Access of lubricant to the crack and consequent tendency for pitting is governed by viscosity, and possibly by the wetting properties of the lubricant. High viscosity is desirable except where power loss and operating temperatures necessitate a compromise.

Part II of this Symposium, "The Testing of Gear Lubricants," comprised eight papers. The development of a test method for gear lubricants on the IAE machine was described by the Panel on "Mechanical Tests of Lubricants," under Standardization Subcommittee No. 5 of the Institute of Petroleum (65). Although this machine is satisfactory for petroleum oils, with or without mild EP additives, it was found that the SAE machine would be more suitable for hypoid-gear lubricants.

Hughes (66) reported on the prediction of service performance from laboratory tests. He concluded that a more fundamental approach to this problem was necessary, but found Blok's critical-temperature hypothesis promising.

Correlation of road and laboratory wear tests on automotive gears was described by Bingham and Withers (67) who relied upon determinations of iron content.

Stone (68) described methods used in the production of lubricant test gears for the IAE machine to insure the highest possible uniformity.

Greenwood and Morton (69) reported on the testing and performance of lubricants for high-speed gears using the IAE gear machine. They investigated the degree of reproducibility obtainable, and came to favorable conclusions in comparison with the earlier types of bench tests.

A full-scale automotive test using British axles, believed equivalent to American tests, was described by Towle (70). This work included high-speed, high-torque, and moisture-corrosion tests.

The disk-testing machine of David Brown & Sons was described by Watson (71), together with surface conditions observed during its use. The best procedure for determining friction and load capacity with different lubricants and different ratios of rolling to sliding is fully discussed. Tests were conducted on both the 3-in. and 6-in. machines. The coefficient of friction decreased with increasing speed, but increased with increasing load except over an intermediate range of loads, where it remained constant. With increase of rubbing speed from zero up, the load capacity for scuffing to occur increased to a maximum, and then fell off sharply.

Service tests on worm gears in practical bus operation were conducted carefully, and fully described by Styles and Wilford (72). Large numbers of vehicles operating for long periods were found necessary to establish reliable conclusions. The value of oxidation-inhibited oils was demonstrated, but the problem of compatibility of oils containing different types of inhibitors remains unsolved. Further research is required on reduction of worm-gear wear.

Wellauer (73) investigated the heat transfer from gearboxes. Newton's law of cooling was assumed and constants determined. Rates of heat generation by friction and churning were found proportional to some power of the speed between the second and third. Charts indicate maximum speed for any allowable temperature rise.

Hutt (74) presented data on the load-carrying capacity of gears, illustrating the fact that under certain conditions the lubricating-oil viscosity affects the scoring load. Tests run on machines using disk and gear specimens indicate pitting can be reduced by increasing the viscosity of the lubricant. He concludes that the choice of lubricant is still an empirical one.

METALWORKING LUBRICATION

A recent development in the field of lubricant research in metalworking was the application of radioactive-tracer technique to metal cutting by Merchant and co-workers. The idea was first described in a brief note at the close of 1951 (75), while the details of the initial application to cutting fluids were presented before the Cincinnati Meeting of ASME in June, 1952 (76). The new method does not involve undue radiation hazard and can be used to assess tool wear under normal cutting speeds. It is much faster and requires less work material than conventional methods. Further, by alternating between two fluids without change of any other cutting conditions, a severalfold increase in precision is realized. The method opens up new avenues for basic studies of the tool-wear process and should prove to be an important factor in understanding this complex subject. It has been shown that over 90 per cent of the wear products from the tool adhere to the chips and very little is flushed away by the cutting fluid.

Evidence continues to accumulate on the importance of applying a cutting fluid to the clearance crevice of the tool in a cutting operation. From an independent analysis of the problem, Pigott (77) has developed a commercial process, called "Hi-Jet," for increasing the effectiveness of cutting fluids which involves forcing them into the clearance crevice by means of high-pressure jets. The optimum pressure is 400 psi while the jet diameter is of the order of 0.015 to 0.025 in. Several jets are used for wide cuts. Oil fog is confined by an oil curtain. Using cutting fluids especially developed for the process, a 7 to 20-fold increase in tool life has been achieved. Lauterbach (78) describes experiments which illustrate the advantage of even mild pressure in directing a stream of lubricant into the clearance crevice and finds a slight benefit for grooves in the tool face. In mild contrast to the foregoing and illustrating the complexity of the machining operation, Stocker (79) reports considerable improvement in tap life in threading brass when the cutting fluid (kerosene, spindle oil, or turpentine) was applied as an oil mist rather than as a flood.

Carbon dioxide has successfully invaded the cutting-fluid field and has proved to be superior to conventional fluids in certain cases. It is applied as a jet (or jets) of pressurized liquid and is particularly useful for some of the newer austenitic alloys whose surface properties are adversely altered by conventional machining procedures and whose value justifies the higher cost of the carbon-dioxide coolant. Tangerman and Brunberg (80) report improved machinability for such diverse work materials as hardened tool-steel, Inconel, titanium, and high-nickel and chromium-cobalt alloys. The advantages of CO_2 include cleanliness, good temperature control, dimensional and metallurgical stability of the work, clear inspection, and no contamination of the work or chips. Kwolek (81), reporting on extensive field tests on grinding at the Cadillac Tank Plant, states that CO_2 coolant increases permissible speed, lengthens wheel life, and improves surface finish. Cerne and Parrat (82) describe a centralized distribution system for liquid CO_2. Goldberg and Hazelton (83) reviewed an extensive joint research program by the Navy and Westinghouse on machining titanium. This metal is prone to galling and to work-hardening and, unless the carbon content is very low, contains abrasive carbides. In addition to recommendations on the preparation of tools and the selection of conventional cutting fluids, the authors also recommend CO_2 for machining this difficult metal.

Roubik (84), in a paper on high-speed carbide-milling, found that soluble-oil emulsions materially shorten tool life when used in face-milling medium-carbon steels (3140, 4340, 4145, and 4145 sulphurized, having 200, 300, or 400 Brinell hardness number). Cutting in still air gave the best performance, while complete flooding gave the poorest. Moreover, tool failure was of a more objectionable type when emulsions were used.

Hain (85) made direct measurements of rate of heat transfer from hot metal surfaces and found significant differences within, as well as between, different classes of fluids, such as mineral oils and soluble-oil emulsions. Full correlations with practice remain to be established.

An outstanding development in lubrication in metal-drawing was the commercial application in the United States of the Ugine-Sigournet process for the hot-extrusion of tubes, rods, and special shapes of high-alloy steels (86). This process, which started in France, has been under development for over ten years and employs glass as the lubricant instead of carbonaceous residues. The outside of the heated billet (1600–2250 F) is coated by rolling over a glass mat just before placing in the extrusion press. Lubricant for the inside is supplied by a Fiberglas sock slipped over the cold mandrel before insertion in the (already pierced) billet. Advantages of the process include increased production, thinner walls of extruded tubes, reduction of scrap, and increased availability of difficult alloys in seamless-tube form.

BOUNDARY LUBRICATION AND FRICTION

General. A number of reviews of recent work pertaining to friction and boundary lubrication appeared. A discussion (87) under the direction of Bowden contributes some new material, particularly on nonmetals, along with a thorough review of friction and boundary lubrication. A report by Pomey (88) reviews friction and wear studies, discussing boundary friction, seizure, and solid friction. Barwell (89) has described the mechanical, physical, and chemical methods of examining surfaces which are useful in studying surface finish, fretting, and so on. Problems involved in high-speed operation of ball and roller bearings are described.

Solid Friction. For many lightly loaded nonmetals, Lincoln (90) has shown that the friction force varies as the $^2/_3$ power of the load. This effect is believed to be due to the low elastic modulus of these materials, which permits them to deform elastically rather than plastically. Contact-area and friction measurements on nylon are used to confirm this theory. Schallmach (91) reports interesting stick-slip patterns obtained by scratching rubber with a needle. Friction experiments are described by Broughton and Gregg (92) who used paper rubbing at low speeds over copper. The study was designed to measure the effect of surface roughness of the paper and other variables on coefficient of friction. Increasing paper roughness, resin content, and filler content increased friction. Calendering with fatty acids reduced friction; paraffin gave the lowest coefficient of friction.

Moore and Tabor (93) demonstrate that the adhesion between clean indium and metal surfaces depends only on the area of contact and time of breaking of the welding junction. Adhesion of indium to metals and nonmetals is closely related to the coefficient of friction; this indicates that the frictional mechanism for sliding nonmetals is related to the cold-welding process in the friction of metals. Studies of the transition state between static and kinetic friction are described by Rabinowicz (94). The static coefficient persists for motion up to about 10^{-4} cm, after which it falls gradually to the kinetic value. Boundary lubricants act by reducing initial metallic interaction and by preventing the increase of area of metallic junctions during sliding.

An interesting variation of modern theories of friction is proposed by Feng (95). He introduces the roughening which individual asperities undergo when in contact under pressure. The exact interlocking of opposing faces under this condition can explain many of the features of friction and wear. Burwell and Strang (96) studied metallic wear as a function of load, length of path, and elastic properties of the metal. Under conditions where metal loss is by galling only, the volume of metal removed is directly proportional to the load and length of path and inversely proportional to flow stress of the softer metal. Godfrey and Bisson (97) show that fretting is the loosening and simultaneous oxidation of finely divided material from the contact area. Through studies of nonreactive materials it appears that oxidation is a secondary reaction. Fretting can be mitigated by the use of resin-bonded molybdenum disulphide.

Boundary Lubrication. Oxide films 1000 Angstrom units in thickness were found by Johnson, Peterson, and Swikert (98) to contribute to the wear resistance of steel. Films of Fe_3O_4 lubricated with 0.5 per cent solution of stearic acid in cetane were highly effective in reducing the wear of steel sliders at high velocities. Murray and Johnson (99) found that certain solvents contribute to lubrication by silicones. Under boundary conditions solvents having dipole moments, such as diesters, permit silicones to lubricate steel satisfactorily. The adsorption on metals of long-chain polar compounds in hydrocarbon solution is described by Daniel (100). Reactions were found to occur with copper, lead, zinc, and cadmium, not with nickel, silver, platinum, chromium, iron, or aluminum. Acids are most strongly adsorbed, alcohols intermediate, and esters least; ease of adsorption increases with chain length.

Extreme-Pressure Lubrication. Resinous materials can be used to bond molybdenum disulphide to surfaces, according to Godfrey and Bisson (101). Lubrication of steel by this material is improved if the surface oxides are reduced to Fe_3O_4, as by corn syrup. Feng (102) finds that molybdenum disulphide films are stable to 400 C. These films have a laminar structure similar to graphite, but they are more adherent than graphite.

Co-operative tests designed to improve the reproducibility of the Timken machine in measuring extreme-pressure properties of lubricants are reported by Levin, Sprague, et al. (103). A test procedure is recommended (see reference 57 for another study of the Timken machine). Nason (104) describes modifications of the Navy procedure for obtaining mean Hertz load value of a lubricant. These changes appreciably shorten the time required to make this determination.

PROPERTIES OF LUBRICANTS

Foaming. The properties required of an antifoaming agent are given by Tourret and White (105). There is no correlation between the formation and stability of foam, as these are quite separate and distinct phenomena. The amount of foam formed depends upon the bulk properties of the liquid, while foam stability depends upon properties of the film. A small percentage of entrained air or gas can seriously interfere with proper functioning of conventional gear pumps at high altitudes.

Smith (106) describes static and flowing hydraulic systems together with hydraulic-fluid requirements; he discusses fluid properties such as compressibility, air entrainment, oxidation stability, corrosion resistance, viscosity, pour point, and availability.

Szebehely (107) found a definite relation between the solubility of air in hydrocarbons and rates of solution and evolution. Four heavy and three light lubricating oils and three aircraft-engine fuels were tested; a relation was established between the time rate of evolution of air and the viscosity of the liquids.

Structure and Properties of Greases. Commercial greases are usually extremely complex systems, as reported by Smith (108). He states that the structure of a soap gel in oil is determined, chiefly, by the composition of the system and its thermal history; the gel structure determines, to a large extent, the texture of the grease and its rheological properties.

Studies were made of the rust-preventive properties of a group of greases by Burger, Rubin, and Glass (109) in the laboratory and in service aircraft. Humidity-cabinet tests were compared with service performance tests of different greases in corresponding locations on equipment. Corrosion-preventing factors include high values of alkalinity, viscosity, or polarity in the oil component, balanced with the proper degree of water resistance, hardening resistance in use, and inhibition provided by certain additives.

Moore and Cravath (110) conclude, from electron micrographs of sodium, calcium, lithium, and barium-base greases, that breakage of the soap fibers occurs during work-softening. The ratio of length to diameter of the fibers changes when fibers are broken, appearing to explain the observed change in consistency.

Evans, Hutton, and Matthews (111) studied lithium soap-oil systems by differential thermal analysis. Data thus obtained on latent heats of phase transformations of the soaps permitted estimates to be made of the solubilities of the soaps in the oil as a function of temperature. Hardness and resistance to oil

separation of lithium greases were determined by the soap phase existing during the growth of the fibers.

A brief description of composition and functional requirements of grease is given by Hotten (112). He discusses theories of the physical structure of greases and presents evidence supporting the microcrystalline-paste theory. He describes structure changes accompanying temperature changes and the relation between colloidal structure and flow properties. Electron micrographs show variation of fiber structure with thickener composition.

An insight into the true structure of greases was gained in a preliminary investigation using the electron microscope, according to Brown, Hudson, and Loring (113), in conjunction with optical-microscope examination. Indications are given of how greases with well-defined fibers will orient their fibers in the bulk grease in a moving system. The formation of long fibers in certain lithium greases is accompanied by gelling effects when heated to transition temperatures.

Phthalocyanine pigments are effective gelling agents for the formation of greases from a wide variety of petroleum and synthetic lubricating fluids. Fitzsimmons, Merker, and Singleterry (114) found that such products retain a useful grease structure above 150 C. They tend to stiffen at elevated temperatures and show smaller torque requirements at very low temperatures.

Burrows and Jackson (115) found merit in the cryoscopic method for determining the molecular weights of low-vapor-pressure organic esters of the plasticizer type and petroleum oils and greases. It is simple to follow and gives results which are in agreement with the results of other methods.

Using an electron microscope, Cunningham and Vela (116) found that calcium-base grease fibers apparently were twisted as in a two-stranded rope. Three distinct forms were observed; one with both strands wound around each other, one with one strand straight with the other wound around it; and a third, braided form with a line of symmetry coinciding with the axis.

MISCELLANEOUS

Because of the inability of a single petroleum oil to perform satisfactorily at extreme high and low temperatures, a synthetic-base lubricant has been developed for use in the turboprop engine. Christensen (117) reports this lubricant has excellent resistance to oxidation and thermal decomposition at 400 F, and will operate at —65 F. Engine tests to determine the necessity of EP additives are in progress.

Goettner (118) describes a "standard oil-relation" index, for determining the temperature dependence of the viscosity of liquids of very low viscosity or with very flat or steep viscosity-temperature curves, and the "standard oil-proportion" index for high-density lubricants.

Boyd (119) reports a tentative list of symbols for use with lubrication problems. The list is offered in co-operation with the Educational Committee of the American Society of Lubrication Engineers.

An accurate determination of the viscosity of water at 20 C has been reported by Swindells, Coe, and Godfrey (120). The value of 0.010019 poise is given, compared to the previously accepted figure of 0.01005. Since water is almost universally used as a basic standard for viscosity determinations, adoption of the new value will require recalibration of viscosimeters.

Booser and Fenske (121) find that the oxidation behavior of lubricating-oil fractions may be predicted generally from data obtained on pure hydrocarbons. The course of the reaction, whether it results in acids or insolubles, depends on the chemical structure. Corrosion studies of lead by Wilson and Garner (122) indicate that the rate of attack is independent of acid concentration. Corrosion depends markedly on the peroxide content, however.

BOOKS

"The Physical Chemistry of Surface Films," by W. D. Harkins (123), published posthumously, contains a great deal of material bearing on the fundamentals of lubrication. Among the subjects touched on are the nature of solid and liquid surfaces, surface and interfacial tensions, the spreading of liquids, adsorption at interfaces, contact angles, emulsions, soap systems, and many others. The treatment is mainly theoretical although a large amount of experimental evidence is included.

Zuidema, in "Performance of Lubricating Oils" (124), summarizes and evaluates a wealth of data on the performance characteristics of lubricating oils under various conditions. Basic data rather than specific applications are shown and discussed. Manufacturing methods for lubricants are also described.

BIBLIOGRAPHY

1 "New Bearing Made of Any Material, Lubricated With Any Fluid," by R. M. Higgins, *Iron Age*, vol. 170, September 11, 1952, pp. 158–160.

2 "Hydrostatic Bearings Minimize Friction in Cradle Dynamometer," by P. S. Potts, *Machine Design*, vol. 24, October, 1952, pp. 180–184.

3 "On Energy Equation for Fluid-Film Lubrication," by A. Charnes, F. Osterle, and E. Saibel, Proceedings of the Royal Society of London, England, vol. 214, August 7, 1952, pp. 133–136.

4 "Stepped Shape Film Applied to Journal Bearings," by R. R. Archibald, *Journal of The Franklin Institute*, vol. 253, 1952, pp. 21–27.

5 "Oil Flow in Plain Journal Bearings," by S. A. McKee, Trans. ASME, vol. 74, 1952, pp. 841–845; discussion, 845–848.

6 "Applying Bearing Theory to Analysis and Design of Journal Bearings," by J. Boyd and A. A. Raimondi, Trans. ASME, vol. 73, 1951, pp. 298–316.

7 "Calculations and Design of Sleeve Bearings," by A. Klemencic, *Journal of the American Society of Naval Engineers*, vol. 64, 1952, pp. 104–119.

8 "An Analysis of the Pivoted Pad-Journal Bearing," by J. Boyd and A. Raimondi, MECHANICAL ENGINEERING, vol. 75, May, 1953, pp. 380–386.

9 "Experimental Investigations of Oil Film Pressure Distribution for Misaligned Plain Bearings," by G. B. DuBois, H. H. Mabie, and F. W. Ocvirk, NACA Technical Note 2507, October, 1951.

10 "Effects of Solids Inclusions in Sleeve-Bearing Oil Supply," by H. G. Rylander, MECHANICAL ENGINEERING, vol. 74, 1952, pp. 963–966.

11 "Electrical Method for Determining Journal-Bearing Characteristics," by D. S. Carter, Trans. ASME, vol. 74, 1952, pp. 114–118.

12 "Oil Film Thickness Indicators," *Petroleum Processing*, vol. 6, October, 1951, pp. 1139–1141. See also:
"Oil Film Thickness Indicators for Sleeve-Type Bearings," *Scientific Lubrication*, vol. 3, November, 1951, pp. 18–19, 34.

13 "A Contribution to the Theory of Oil Whip," by H. Poritsky, Trans. ASME, vol. 75, 1953, pp. 1153–1162.

14 "Oil Whip of Flexible Rotors," by A. C. Hagg and P. C. Warner, Trans. ASME, vol. 75, 1953, pp. 1339–1344.

15 "Discrepancies Between Theoretical and Observed Behavior of Cyclically Loaded Bearings," by R. W. Dayton, E. M. Simons, and F. A. Fend, NACA Technical Note 2545, November, 1951.

16 "An Investigation of Cemented Tungsten Carbide as Bearing Material," by J. S. Kozacka, H. A. Erickson, H. W. Highriter and A. F. Gabriel, Trans. ASME, vol. 75, 1953, pp. 1203–1210.

17 "Plastics Versus Metals in Bearings," by R. H. Warring, *Mechanical World*, vol. 131, January, 1952, pp. 27-28.

18 "The Design and Manufacture of Jewels and Pivots for Instruments and Meters," by G. F. Tagg and E. A. Howell, Society of Instrument Technology, Trans., vol. 3, September, 1951, pp. 124–133.

19 "Indium Alloys Finding Important Commercial Uses," by R. I. Jaffee and S. M. Weiss, *Materials and Methods*, vol. 36, September, 1952, pp. 113–115.

20 "Material Specifications for Oil-Film Bearings," by E. B. Etchells, *Lubrication Engineering*, vol. 8, 1952, pp. 291–292, 312–313.

21 "Tired Bearings—Reasons and Remedies," by J. Palsulich, *Lubrication Engineering*, vol. 8, 1952 pp. 293–294, 313–314.

22 "Role of the Lubricant in Bearing Fatigue," by E. S. Carmichael and R. B. Purdy, *Lubrication Engineering*, vol. 8, pp. 295–297, 314, 316.

23 "What Is Bearing Fatigue?" by A. E. Roach and L. G. Johnson, Preprint American Society of Lubrication Engineers, April 8, 1952, Cleveland, Ohio.

24 "Lubrication and Cooling Studies of Cylindrical Roller Bearings at High Speeds," by E. F. Macks and Z. N. Nemeth, NACA Report 1064, 1952, and Technical Note 2420, 1951.

25 "Influence of Lubricant Viscosity on Operating Temperatures of 75 Millimeter Bore Cylindrical Roller Bearing at High Speeds," by E. F. Macks, W. J. Anderson, and Z. N. Nemeth, NACA Technical Note 2636, February, 1952.

26 "The Dynamic Capacity of Roller Bearings," by G. Lundberg and A. Palmgren, *Engineers Digest*, vol. 13, July, 1952, pp. 217–219. Complete article *Acta Polytechnica*, Mechanical Engineering Series, vol. 2, no. 4, issue 96, 1951.

27 "Noise and Vibration in Ball Bearings," by G. H. Kendall, *Product Engineering*, vol. 22, December, 1951, pp. 150–155.

28 "Preliminary Investigation of Wear and Friction Properties Under Sliding Conditions of Materials Suitable for Cages of Rolling-Contact Bearings," by R. L. Johnson, M. A. Swikert, and E. E. Bisson, NACA Technical Note 2384, June, 1951, 33 pp.

29 "Adventures in Lubrication," by D. F. Wilcock, *Lubrication Engineering*, vol. 7, December, 1951, pp. 277–280.

30 "The Lubrication of Gyroscopes," by J. E. Brophy and J. B. Romans, Trans. ASME, vol. 75, August, 1953, pp. 1147–1152.

31 "Elastic Sphere Under Concentrated Loads," by E. Sternberg and F. Rosenthal, *Journal of Applied Mechanics*, Trans. ASME, vol. 74, 1952, pp. 413–421.

32 "Stresses Due to Tangential and Normal Loads on an Elastic Solid With Application to Some Contact Stress Problems," by J. O. Smith and Chang Kang Liu, *Journal of Applied Mechanics*, Trans. ASME, vol. 75, 1953, pp. 157–166.

33 "On the Solution of the Reynolds Equation for Slider-Bearing Lubrication II, The Viscosity a Function of the Pressure," by A. Charnes and E. Saibel, Trans. ASME, vol. 75, 1953, pp. 269–272.

34 "On the Solution of the Reynolds Equation for Slider-Bearing Lubrication III, Effect of Transverse Curvature," by A. Charnes, E. Saibel, and A. Ying, Trans. ASME, vol. 75, 1953, pp. 507–513.

35 "On the Solution of the Reynolds Equation for Slider-Bearing Lubrication—IV, Effect of Temperature on the Viscosity," by F. Osterle, A. Charnes, and E. Saibel, Trans. ASME, vol. 75, 1953, pp. 1117–1123.

36 "On the Solution of the Reynolds Equation for Slider-Bearing Lubrication—V, The Sector Thrust Bearing," by A. Charnes, E. Saibel, and S. C. Ying, Trans. ASME, vol. 75, August, 1953, pp. 1125–1132.

37 "On the Solution of the Reynolds Equation for Slider-Bearing Lubrication—VI, The Parallel-Surface Slider-Bearing Without Side Leakage," by F. Osterle, A. Charnes, and E. Saibel, Trans. ASME, vol. 75, 1953, pp. 1133–1136.

38 "Experiments With Water-Lubricated Tapered-Land Thrust Bearings," by M. Levinsohn and N. E. Reynolds, Trans. ASME, vol. 75, 1953, pp. 1137–1145.

39 "Recent Developments in Hydroelectric Thrust Bearings," by A. B. Lakey, presented at the Annual Meeting, New York, N. Y., November 30–December 5, 1952, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

40 "Études Experimentales sur le Fonctionnement des Pivoteries Industrielles," by S. X. Casacci and A. Peuchmaur, *Houille Blanche*, vol. 6, January–February, 1951, pp. 23–43.

41 "Das Stromungs-Spurlager," by G. Heinrich, *Maschinenbau u Wärmewirtschaft*, vol. 6, April 5, 1951, pp. 57–60; May, 1951, pp. 78–82.

42 "Pivots pour Turbines Hydrauliques," by J. Chappuis, *Schweizerische Bauzeitung*, vol. 69, 1951, pp. 553–555.

43 "Hydrodynamic Lubrication of Rotating Disks in Pure Sliding. New Type of Oil Film Formation," by A. Cameron, *Journal of the Institute of Petroleum*, vol. 37, 1951, pp. 471–486.

44 "Field Performance of Detergent Type Motor Oils in Gasoline Powered Vehicles," by A. C. Pilger, Jr., Trans. of the SAE, vol. 6, 1952, pp. 424–436.

45 "High Additive Oils in the City, on the Long Lines, and Off the Road," by J. A. Edgar, *SAE Journal*, vol. 60, January, 1952, pp. 49–52.

46 "Where and Why of Engine Deposits," by R. S. Spindt and C. L. Wolfe, *SAE Journal*, vol. 60, May, 1952, pp. 39–44.

47 "Oil Filtration Problems With High Detergency Lubricants," by H. M. Gadebusch, R. T. Karr, and W. B. Bassett, *SAE Journal*, vol. 60, April, 1952, pp. 33–37.

48 "Low-Temperature Lubrication of Aircraft Engines," by Saul Barron, Trans. of the SAE, 1952, pp. 175–195.

49 "Flight Research Experience With Higher Engine Oil Temperatures," by D. N. Harris, F. R. Watson, T. Frame-Thompson, and D. C. McMacken, *SAE Journal*, vol. 59, December, 1951, pp. 28–35.

50 "Observation of Lubricating Oil Film Between Piston Ring and Cylinder of Running Engine—Effects of Ring Geometry," by R. L. Brooks and M. L. Atkin, Australia Aeronautical Research Consultative Committee Report ACA-52, November, 1950, p. 13.

51 "Late Development in Piston Ring Design," by H. G. Braendel, *World Oil*, August, 1951, pp. 234–236.

52 "Diesel Lubricated-Oil Performance as Related to the Electron Microscope," by Ray McBrian, ASME Preprint No. 52—A-40, November 30–December 5, 1952.

53 "Diesel Maintenance Control by Spectrographic Means," by H. R. Sennstrom, ASME Paper 52—A-61; see also *Railway Mechanical and Electrical Engineer*, April, 1952, pp. 65–68.

54 "Spectrographic Determination of Lubricating Oil Additives," by J. P. Pagliassotti and F. W. Porsche, *Anal. Chem.*, vol. 23, 1951, pp. 1820–1823.

55 "Gear Lubricant—A Constructional Gear Material," by H. Blok, *De Ingenieur*, vol. 63, September 28, 1951, pp. 53–64.

56 "Zahnradforschung und Schmierstoff," by E. Heidebroek, *Zeitschrift des Vereines deutscher Ingenieure*, vol. 93, 1951, pp. 1012–1014.

57 "Effect of Variations in Viscosity of Lubricants Upon Timken OK and Psi Values," by I. S. Kolarik, C. A. Zeiler, and E. M. Kipp, Trans. ASME, vol. 74, 1952, pp. 875–878.

58 "Hydrodynamic Theory in Gear Lubrication," by A. Cameron, *Journal of the Institute of Petroleum*, vol. 38, 1952, pp. 614–622.

59 "Gear-Tooth Wear," by G. I. Finch and R. T. Spurr, ibid., pp. 623–624.

60 "Criteria Governing Scuffing Failure," by F. T. Barwell and A. A. Milne, ibid., pp. 624–632.

61 "Some Factors Affecting Gear Scuffing," by H. D. Mansion, ibid., pp. 633–645.

62 "The Effect of Variations of Viscosity With Pressure on the Load-Carrying Capacity of the Oil Film Between Gear-Teeth," by E. McEwen, ibid., pp. 646–650.

63 "Note on Performance of Graphited Oil," by E. A. Smith, ibid., pp. 650–652.

64 "The Wear and Pitting of Bronze Disks Operated Under Simulated Worm-Gear Conditions," by L. S. Evans and R. Tourret, ibid., pp. 652–668.

65 "The Development of a Test Method for Gear Lubricants on the IAE Machine," by the Mechanical Tests of Lubricants Panel of Standardization Subcommittee No. 5, *Journal of the Institute of Petroleum*, vol. 38, 1952, pp. 705–711.

66 "From Test Machine to Gear-Box; Problems Associated With the Translation of Laboratory Test Results Into Predictions of Field-Service Performance of Gear Lubricants," by J. R. Hughes, ibid., pp. 712–718.

67 "Road and Laboratory Wear Tests of Gear Oils," by H. L. Bingham and J. G. Withers, ibid., pp. 718–728.

68 "Production of Lubricant Test Gears," by R. D. B. Stone, ibid., pp. 728–732.

69 "The Testing and Performance of Lubricants for High-Speed Gears," by J. Greenwood and R. S. Morton, ibid., pp. 732–746.

70 "Developments in the Specifications and Testing of Lubricants for Hypoid Axles With Particular Reference to a Full-Scale British Test Procedure," by A. Towle, ibid., pp. 747–762.

71 "The Testing and Selection of Gear Lubricants," by H. J. Watson, ibid., pp. 763–774.

72 "Service Tests in Rear Axles of Buses and Trolley-Buses," by H. E. Styles and A. T. Wilford, ibid., pp. 775–782.

73 "Solving the Thermal Problem for Enclosed Gear Drives," by E. J. Wellauer, *Machine Design*, vol. 24, March, 1952, pp. 123–127.

74 "Lubrication and the Load-Carrying Capacity of Gears," by E. T. Hutt, *Lubrication Engineering*, vol. 8, 1952, pp. 180–182, 201–203.

75 "Radioactive Tracers for Rapid Measurement of Cutting Tool Life," by M. E. Merchant and E. J. Krabacher, *Journal of Applied Physics*, vol. 22, 1951, pp. 1507–1508.

76 "Radioactive Cutting Tools for Rapid Tool-Life Testing," by M. E. Merchant, Hans Ernst, and E. J. Krabacher, Trans. ASME, vol. 75, 1953, pp. 549–559.

77 "Hi-Jet System for Increasing Tool Life," by R. J. S. Pigott and A. T. Colwell, SAE Quarterly Transactions, vol. 6, 1952, pp. 547–564; discussion, pp. 564–566. See also:

"Cutting-Tool Jet Lubrication," MECHANICAL ENGINEERING, vol. 74, 1952, pp. 148–149.

78 "Influence of Point of Application of Cutting Oil on Tool Life," by W. E. Lauterbach, *Lubrication Engineering*, vol. 8, June, 1952, pp. 135–136.

79 "Sprayed Vapor Ups Tap Life and Speed," by W. M. Stocker, Jr., *American Machinist*, vol. 96, January 7, 1952, p. 121.

80 "CO_2 Cools Tools to Machine the 'Unmachinable,'" by E. J. Tangerman and P. E. Brunberg, *American Machinist*, vol. 96, March 3, 1952, pp. 129–132.

81 "Carbon Dioxide Coolant Lowers Tool Grinding Costs," by J. Kwolek, *Iron Age*, vol. 170, August 14, 1952, pp. 124–125.

82 "Central System Distributes CO_2 Coolant for Grinding," by P. S. Cerne and C. O. Parrat, *Iron Age*, vol. 170, August 14, 1952, pp. 126–128.

83 "How to Machine Titanium," by D. C. Goldberg and W. S. Hazelton, *Iron Age*, vol. 169, April 17, 1952, pp. 107–110.

84 "Carbide Steel Milling With Cutting Fluids—A Progress Report," by J. R. Roubik, *Lubrication Engineering*, vol. 8, October, 1952, pp. 235–237, 261.

85 "Measuring the Cooling Properties of Cutting Fluids," by G. M. Hain, Trans. ASME, vol. 74, 1952, pp. 1079–1079; Discussion pp. 1079–1082.

86 "New Method Makes Stainless Extrusion Practical," Anon., *Steel*, vol. 130, June 2, 1952, pp. 92–96.

87 "Discussion of Friction," by F. P. Bowden, Discussion Leader, Proceedings of the Royal Society of London, vol. 212, 1952, p. 440.

88 "Friction and Wear," by T. Pomey, NACA Technical Memorandum 1318. Translation of "Le Frottement et l'Usure" Office National d'Etude et de Recherches Aeronautiques Rapport Technique No. 36, 1948, Travaux Groupement Francais pour le Developement des Recherches Aeronautiques (GRA).

89 "Some Aspects of Research on Friction and Wear," by F. T. Barwell, Institution of Shipbuilders in Scotland, vol. 95, part 2, 1950, pp. 64–100.

90 "Frictional and Elastic Properties of High Polymeric Materials," by B. Lincoln, *British Journal of Applied Physics*, vol. 3, 1952, p. 1260.

91 "Elementary Aspects of Rubber Abrasion," by A. Schallmach, *Engineering*, vol. 173, 1952, p. 218.

92 "Some Observations on the Kinetic Coefficient of Friction of Paper," by G. Broughton and Joan L. Gregg, *Tappi*, vol. 35, 1952, p. 489.

93 "Some Mechanical and Adhesive Properties of Indium," by A. C. Moore and D. Tabor, *British Journal of Applied Physics*, vol. 3, 1952, p. 299.

94 "Nature of the Static and Kinetic Coefficients of Friction," by E. Rabinowicz, *Journal of Applied Physics*, vol. 22, 1951, p. 1373.

95 "Metal Transfer and Wear," by I-Ming Feng, *Journal of Applied Physics*, vol. 23, 1952, p. 1011.

96 "On the Empirical Law of Adhesive Wear," by J. T. Burwell and C. D. Strang, *Journal of Applied Physics*, vol. 23, 1952, p. 18.

97 "NACA Studies of Mechanism of Fretting (Fretting Corrosion) and Principles of Mitigation," by D. Godfrey and E. E. Bisson, *Lubrication Engineering*, vol. 8, 1952, pp. 241–243, 262–263.

98 "Friction at High Sliding Velocities of Oxide Films on Steel Surfaces Boundary Lubricated With Stearic Acid Solutions," by R. L. Johnson, M. D. Peterson, and M. A. Swikert, NACA Technical Note 2366, May, 1951.

99 "Effects of Solvents in Improving Boundary Lubrication of Steel by Silicones," by S. F. Murray and R. L. Johnson, NACA Technical Note 2788, September, 1952.

100 "The Adsorption on Metal Surfaces of Long Chain Polar Compounds From Hydrocarbon Solutions," by S. G. Daniel, Trans. of the Faraday Society, vol. 47, 1951, p. 1345.

101 "Bonding of Molybdenum Disulfide to Various Materials to Form a Solid Lubricating Film," by D. Godfrey and E. E. Bisson, NACA Technical Note No. 2628, 1952.

102 "Lubricating Properties of Molybdenum Disulfide," by I-Ming Feng, *Lubrication Engineering*, vol. 8, 1952, pp. 285–288, 306–308.

103 "Measurement of Extreme Pressure Properties of Lubricants," by H. Levin, H. G. Sprague, and Collaborators, ASTM Bulletin No. 181, April, 1952, p. 143.

104 "The Four Ball Extreme Pressure Tester," by D. K. Nason, *The Institute Spokesman*, vol. 15, March, 1952, p. 23.

105 "Aeration and Foaming in Lubricating Oil Systems," by R. Tourret and N. White, *Aircraft Engineering*, vol. 24, May, 1952, pp. 122–130, 137.

106 "Selection of Oils for Industrial Hydraulic Systems," by A. C. Smith, *Scientific Lubrication*, vol. 3, July, 1951, pp. 20–24, 26.

107 "Relation Between Gas Evolution and Physical Properties of Liquids," by V. G. Szebehely, *Journal of Applied Physics*, vol. 22, 1951, pp. 627–628.

108 "Phase Behavior of Lubricating Greases," by T. D. Smith, *Petroleum*, vol. 15, January, 1952, pp. 5–8.

109 "A Study of Rust Preventive Properties of Greases," by R. J. Burger, B. Rubin, and E. M. Glass, *Lubrication Engineering*, vol. 8, February, 1952, pp. 21–23, 26–27, 46.

110 "Mechanical Breakdown of Soap-Base Greases," by R. J. Moore and A. M. Cravath, *Industrial and Engineering Chemistry*, vol. 43, 1951, pp. 2892–2897.

111 "The Influence of Soap-Phase Structure on Some Physical Properties of Lithium Greases," by D. Evans, J. F. Hutton, and J. B. Matthews, *Journal of Applied Chemistry*, vol. 2, 1952, pp. 252–262.

112 "Fundamental Knowledge of Lubricating Grease Structure," by H. W. Hotten, *Lubricating Engineering*, vol. 8, 1952, pp. 244–246.

113 "Electron Microscope Study of Lithium Greases," by J. A. Brown, C. N. Hudson, and L. D. Loring, *The Petroleum Engineer*, vol. 24, February, 1952, pp. C31–C36.

114 "Phthalocyanine Lubricating Greases," by V. G. Fitzsimmons, R. L. Merker, and C. R. Singleterry, *Industrial and Engineering Chemistry*, vol. 44, 1952, pp. 556–563.

115 "Determination of the Molecular Weights of Low Vapor Pressure Oils and Greases," by G. Burrows and R. Jackson, *Vacuum*, vol. 2, January, 1952, pp. 50–55.

116 "Take a Look at Lime-Base Greases Through an Electron Microscope," by W. A. Cunningham and M. A. Vela, *Petroleum Refiner*, vol. 31, June, 1952, pp. 110–112.

117 "The Development of a Turbo-Prop Synthetic Lubricant," by L. D. Christensen, *Lubrication Engineering*, vol. 8, August, 1952, pp. 177–179, 197–200.

118 "The Evaluation of Synthetic Lubricants," by G. H. Goettner, *Chemie-Ingenieur Technik*, vol. 23, April 14, 1951, pp. 157–160.

119 "Proposed List of Mathematical Symbols for Lubrication Problems," by J. Boyd, *Lubrication Engineering*, vol. 7, December, 1951, pp. 282–283.

120 "Absolute Viscosity of Water at 20° C," by J. F. Swindells, J. R. Coe, Jr., and T. B. Godfrey, *Journal of Research*, National Bureau of Standards, vol. 48, 1952, pp. 1–31.

121 "Liquid Phase Hydrocarbon Oxidation," by E. R. Booser and M. R. Fenske, *Industrial and Engineering Chemistry*, vol. 44, 1952, pp. 1850–1856.

122 "The Role of Peroxides in the Corrosion of Lead by Lubricating Oils," by B. S. Wilson and F. H. Garner, *Journal of the Institute of Petroleum*, vol. 37, 1951, pp. 225–238.

123 "The Physical Chemistry of Surface Films," by W. D. Harkins, Reinhold Publishing Corporation, New York, N. Y., 1952, 425 pp.

124 "Performance of Lubricating Oils," by H. H. Zuidema, Reinhold Publishing Corporation, New York, N. Y., 1952, 179 pp.

Engineering Mode of Analysis

(*Continued from page 800*)

encourage him to develop skills in the various techniques used in the analysis of an actual system.

REFERENCES

1 "The Nature of Engineering," by M. P. O'Brien, *Journal of Engineering Education*, vol. 41, November, 1950, pp. 133–142.

2 "Differentiating Characteristics of an Engineering Curriculum," by S. C. Hollister, MECHANICAL ENGINEERING, vol. 72, 1950, pp. 122–123.

3 "A Technique of Problem Solution," by L. M. K. Boelter, *The Journal of Philosophy*, vol. 40, March 4, 1943, pp. 127–133.

4 "Some Observations on Learning," by L. M. K. Boelter, *Journal of Engineering Education*, vol. 37, January, 1947, pp. 419–440.

5 "Heat Transfer Notes," by L. M. K. Boelter, V. H. Cherry, H. A. Johnson, and R. C. Martinelli, University of California Press, 1948.

6 "Technical Papers of R. C. Martinelli." (Many feel that Dr. Martinelli had an unusual ability in the application of the modes of analysis in the solution of an engineering system. This ability is clearly reflected in his many technical papers.)

7 "Similitude in Engineering," by G. Murphy, The Ronald Press Company, New York, N. Y., 1950.

8 "Model Analysis Aids Designers," by M. E. Harvey, *Machine Design*, vol. 20, January, 1948, pp. 120-121.

9 "Wind-Tunnel Tests to Establish Stack Height for Riverside Generating Station," by H. L. von Hohenleiten and F. F. Wolf, Trans. ASME, vol. 64, 1942, pp. 671–683.

10 "Spillway Coefficients," Morris Dam, by G. H. Hickox, Trans. ASCE, vol. 109, 1944, pp. 68–76.

11 "Wind Forces on a Tall Building," by J. C. Rathbun, Trans. ASCE, vol. 105, 1940, pp. 1–82.

12 "Earthquake Resistance of Elevated Water Tanks," by A. C. Ruge, Trans. ASCE, vol. 103, 1938, pp. 889–949.

13 "Modern Developments in Fluid Dynamics," by S. Goldstein, Oxford University Press, New York, N. Y., vol. 1, 1938, p. 62.

14 "Analogs—Tools of Engineering," by W. W. Soroka, *Journal of Engineering Education*, vol. 40, May, 1950, pp. 514–521.

15 "Mechanical Problems Solved Electrically," by G. D. McCann and H. E. Criner, *Westinghouse Engineer*, March, 1946.

16 "Dynamical Analogies," by H. F. Olsen, D. Van Nostrand Company, New York, N. Y., 1948.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

J. J. JAKLITSCH, JR., *Technical Editor*

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Atomic-Energy Report

THE Fourteenth Semiannual Report of the Atomic Energy Commission, which covers the first six months of 1953, points out that this has been a period of consolidating advances in production which began two years or more ago with actions to expand processing-plant capacity and the uranium supply both at home and abroad. South Africa came more prominently into the uranium supply situation, and United States production and exploration mounted in volume.

During these six months the new feed materials plant at Fernald, Ohio, and portions of the new fissionable materials plants at Oak Ridge, Tenn., Paducah, Ky., and supporting facilities at Savannah River, S. C., joined the production stream. The net result of the additions and changes in plants and operations was again, as in each half-year of the past five, more output at lower cost per unit.

Construction continued at an accelerating pace on the 3.5 billion in additional plant facilities yet to be completed under previous Congressional authorizations. Atomic-energy projects account at present for about 3 per cent of the expenditures for new construction in the United States. The proportion next year will be five per cent.

Weapons development was substantially advanced as an outcome of the longest and most complex series of tests yet held. The report includes data on fall-out of radioactive particles resulting from tests.

As in previous tests, no hazard to health or safety of populated areas resulted. There were livestock injuries in areas very near the proving ground where animals graze at the risk of the owners. Final study of livestock cases is still in progress and results were incomplete as this report went to press.

In the field of biological and medical applications the outstanding event of the period was the completion of the cancer-research hospital at the Argonne National Laboratory. Marking this occasion, this report briefly reviews the status of AEC studies in the drive against cancer.

The equipment for physical research in atomic energy was further expanded. A new computer was installed at New York University and new computing machines for Argonne and Oak Ridge National Laboratories were virtually completed.

REACTOR DEVELOPMENT

The events for which the period may be remembered best, however, occurred in the reactor and power phases of the atomic-energy program. According to the report, this period included a greater number of significant events in reactor development than any previous six months in the Commission's history. These events indicated accelerating progress in the development of reactors for power generation, nuclear propulsion, and improved production of fissionable material.

"Breeding," or producing as much nuclear fuel as is consumed in a reactor, was successfully demonstrated in the Experimental Breeder Reactor at the National Reactor Testing Station in Idaho. This demonstration reinforced the belief that known resources of uranium may be large enough to constitute a major source of energy for many years. The Homogeneous Reactor Experiment at Oak Ridge National Laboratory generated useful amounts of electric energy while operating at its full design power. The land-based prototype of the Submarine Thermal Reactor at the National Reactor Testing Station achieved "criticality" and entered subsequent testing prior to operation at full power. The chemical plant for recovering "unburned" fissionable material from spent reactor-fuel elements was placed in operation at the National Reactor Testing Station.

In addition to these achievements, the Commission developed a positive policy designed to recognize the development of economic nuclear power as a national objective. It is believed that the development of competitive nuclear power will be hastened by this policy position, which will promote and encourage free competition and private investment in development, while at the same time accepting on the part of Government certain responsibilities for furthering technical progress in this field to provide a broader basis for such development.

RESEARCH AND TESTING REACTORS

The Materials Testing Reactor, located at the National Reactor Testing Station in Idaho, was operated on a continuous basis. This reactor, operated by the Phillips Petroleum Com-

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources: i.e. (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

pany, provided irradiation facilities for more than 110 tests being performed in the reactor development program. Thirteen irradiation experiments have been completed.

Much specific information was released concerning the irradiation facilities, power level, neutron fluxes, and coolant temperatures of the MTR. These data will permit the most effective utilization of the reactor for the production of special radioisotopes for unclassified use, and for the planning of unclassified basic irradiation experiments. Some significant data on the MTR are as follows:

Design power level	30,000 kw
Coolant	Water
Coolant temperatures	100 F inlet; 111 F outlet
Coolant flow rate	20,000 gpm
Fast neutron flux available for irradiation experiments	1×10^{14} (100 million million) neutrons per sq cm per sec
Maximum thermal neutron flux available for irradiation experiments	4×10^{14} (400 million million) neutrons per sq cm per sec

Experimental Breeder Reactor. Laboratory analyses of representative samples from the fuel elements of the core and from the natural uranium blanket that surrounds the core of the Experimental Breeder Reactor have disclosed that the amount of new fissionable material (plutonium) produced in the reactor is at least equal, taking into account chemical separation losses, to the amount of uranium 235 burned during an extended period of operation. These results confirm the belief in the feasibility of the breeding process as outlined in 1944 by a group of scientists at the Metallurgical Laboratory, operated by the University of Chicago for the Manhattan Engineer District.

The only fissionable fuel that occurs in nature is uranium 235, which constitutes less than 1 per cent of normal, natural uranium. The more common form of the element—uranium 238—may be converted into plutonium in a nuclear reactor. However, until breeding was demonstrated in the EBR, scientists were not certain that plutonium could be produced in amounts equal to or greater than the fuel consumed.

The significance of the breeding process is that in theory all of the world's supply of mineable uranium and thorium can be made to undergo fission.

The EBR is continuing in operation at the National Reactor Testing Station, producing more data relating to the problems associated with breeding. It was designed and is operated by Argonne National Laboratory.

Homogeneous Reactor Experiment. Successful operation of the Homogeneous Reactor Experiment at full design power, with generation of about 150 kw of useful electricity, was accomplished on February 24, at the Oak Ridge National Laboratory. (MECHANICAL ENGINEERING, May, 1953, pp. 405 and 406.) This is the second reactor to generate electricity on an experimental basis. The first electric power from nuclear energy was produced by the EBR in December, 1951.

The basic purpose in building the HRE was to determine whether a circulating fuel reactor would operate smoothly. Tests have shown that the reactor operates without large nuclear fluctuations. The HRE represents an approach to nuclear power in which it is hoped that large economies may result from the use of liquid fuel, minimizing costs of fuel fabrication and chemical processing.

Experimental operation of the HRE is continuing, with the purpose of solving many remaining chemical and design problems.

NAVAL REACTORS

On March 31 it was announced that the land-based prototype of the Submarine Thermal Reactor at the National Reactor Testing Station had achieved "criticality," which means that the nuclear components of the reactor had begun to sustain a chain reacton. On May 31 the reactor first generated substantial amounts of power. Further testing and operation are continuing as the plant gradually is being brought to full power. These experiments will serve to train the crew of the *USS Nautilus* and to determine the operating characteristics of the submarine's power plant, which will be similar to this land-based prototype. The STR is a joint Argonne National Laboratory-Westinghouse Electric Corporation project. (MECHANICAL ENGINEERING, June, 1953, page 486.)

Submarine Intermediate Reactor. The General Electric Company, through the Knolls Atomic Power Laboratory and through subcontractors, continued construction of the land-based prototype of the Submarine Intermediate Reactor and its power plant at West Milton, N. Y. The first group of naval officers and enlisted trainees has reported for training and will assist in the operation of the reactor and power plant. These men are the nucleus of the crew that will man the *USS Sea Wolf*, which will be powered by an SIR-type reactor.

Submarine Advanced Reactor. Design work by the Knolls Atomic Power Laboratory, with assistance from the Argonne National Laboratory, is under way for developing an advanced nuclear power plant for a submarine of significantly higher speed than the first two nuclear-powered submarines.

Large Ship Reactor. At the close of fiscal 1953 the military requirement for a prototype reactor to power a large ship was removed. However, the pressurized water design that had been considered the best approach for a ship reactor also has promise for central station power. The Commission is continuing research and development work on the pressurized water reactor.

AIRCRAFT REACTORS

Construction contracts aggregating approximately $5.5 million were awarded in March for the administration and assembly and maintenance areas for the ground test facilities at the National Reactor Testing Station in Idaho and for other facilities at Oak Ridge National Laboratory required in the program for the development of an aircraft propulsion reactor. The military requirements for an aircraft reactor have been modified and the program has been recast to develop the best possible nuclear power system.

Design and development work is continuing at the Aircraft Gas Turbine Division of the General Electric Company at Evandale, Ohio, and at Oak Ridge National Laboratory, where work on alternate systems is being conducted. A Commission contract with Pratt and Whitney Aircraft Division of United Aircraft Corporation, East Hartford, Conn., was consummated in June for aircraft nuclear propulsion development work.

CHEMICAL PROCESSING PLANT

The new chemical processing plant at the National Reactor Testing Station, operated by the American Cyanamid Company, began operation in February. This plant was designed to recover fissionable material from used reactor-fuel elements from a variety of nuclear reactors. Cost of the plant, with presently planned processing facilities, is approximately $34 million.

INDUSTRIAL PARTICIPATION

Condensed declassified versions of the reports submitted in the summer of 1952 by the first four industrial groups studying the feasibility of power-producing reactors were prepared with the assistance of the Advisory Committee on Industrial Information. (MECHANICAL ENGINEERING, June, 1953, pp. 481–485.)

They were released publicly on May 31 and may be obtained from the U. S. Government Printing Office.

Flameproofed Cloth

CLOTHING, with a special chemical treatment, which will not burst into flame even when exposed to the intense heat of a blowtorch was demonstrated recently by the Treesdale Laboratories and Textile Processing Company of Pittsburgh, Pa., at the Ambassador Hotel, New York, N. Y., to a group of press, public safety, and textile officials. The flameproof compound, called "Permaproof 300," when applied to cotton cloth, is said to provide a durable finish impervious to combustion even at temperatures up to 4500 F. The Permaproofed cloth, of which several million yards have been in actual use, was described as the first finish of its kind which may be laundered repeatedly without losing its fire-retardant properties, a development sought for years by textile chemists.

John A. Beattie, president of Treesdale Laboratories, which developed the compound, explained that safety garments so flameproofed have been "road-tested" for the past five years at the Pittsburgh Works of the Jones & Laughlin Steel Corporation, with excellent results. They are now being used in other steel mills and industries where fire and intense heat are working factors, he said.

The process, he declared, was applicable to a variety of other uses in addition to safety clothing, including cotton bed ticking and mattress covers, some upholstery and drapery fabrics, and "certain other items which annually run up huge fire losses" resulting from dropped cigarettes, lighted matches, and similar careless or accidental causes.

He explained that the steel industry was selected as a proving ground in 1948 because, although among the five "safest" industries in American industry, it has certain working areas of intense heat and men are subject to serious burns.

"The record to date has proved the flameproofed cotton garments can withstand terrific heat and stand up under the most savage kind of working conditions while affording a greater amount of protection than had previously been possible with untreated cloth," Mr. Beattie said. "Men have been showered with hot metal and even have been caught in slag-pit explosions without suffering body burns while wearing the protective clothing. Furthermore, the clothing can be laundered repeatedly, both service and laboratory tests showing the finish will last the life of the garment."

The Permaproof compound is impregnated into the fiber of the cloth during the final finishing process in a textile mill and requires only standard finishing equipment. The impregnant does not noticeably affect the porosity of the cloth and it adds toughness by increasing the tensile strength and abrasion resistance. Actual service reports indicate that the treated cotton garments have been outwearing conventional wool and other untreated fibers by as much as five times. Also, no cases of dermatitis have been reported either from handling the finish or from wearing the treated clothing.

In addition, a special knee-length coat was displayed, which besides being flameproofed, also has an aluminum-foil inner-liner which serves to reflect a great amount of heat away from the body. Some tests were said to show as high as 80 per cent reflectivity values. As a result of this, steelworkers are able to enter furnaces which have been "cooled" to 700 to 800 F and make welding and other repairs. Formerly, with the use of conventional and more costly asbestos coats, they were able to withstand such temperatures for periods not exceeding 15 sec. The aluminum-foil coats permit them to remain inside a furnace up to three minutes at a time, it was said.

The company, it is reported, has filled a number of Government orders for the flameproofing of tent liners and mattress tickings and is now expanding its facilities to treat a wide line of civilian goods, including mattress covers and certain upholstery and drapery fabrics.

FIG. 1 THESE STEELWORKERS, WEARING SPECIAL COTTON SAFETY CLOTHING, MOVE IN CLOSELY ON A FLAMING SMOKING MASS OF MOLTEN STEEL AS IT FLOWS FROM OPEN-HEARTH FURNACE TO LADLE

(The permaproofed coats are lined with aluminum foil which reflects a great part of the intense heat away from their bodies. Ordinary clothing would burst into flame if exposed to such terrific temperatures. Steel, when poured, registers approximately 2900 F.)

Rail Trailer-Auto Loading

SOME interesting systems of loading and shipping highway truck trailers and automobiles in railroad flatcars were displayed at the Railway Manufacturers Association exhibit held recently at Atlantic City, N. J., in conjunction with the Association of American Railroads Convention and the Eighth Pan-American Railway Congress.

SHIPPING HIGHWAY TRUCK TRAILERS

Using a set of scale models, Pullman-Standard Car Manufacturing Company exhibited its experimental method of shipping highway truck trailers on railroad flatcars. This system, engineers pointed out, proposes to employ a new type of cushion-underframe flatcar with built-in hold-down devices that are applicable to existing truck trailers with little modification.

Designed for high-speed shuttle service between major cities on individual railroads, the system resulted from extensive study of technical and economic problems involved in trailer-on-flatcar operation, according to company engineers.

Fast loading and unloading from road to rail was demonstrated by the side-loading scale model wherein a pair of merchandise-loaded trailers can be backed from a car-side dock onto an equipped flatcar spotted on a depressed track. Once on the car, the trailer is latched onto a solid bumperlike bulkhead, and each trailer's kingpin is set down and locked into a stanchion. A special-purpose lift truck provides motive power for the system at the loading dock.

A simple traffic control is advocated in the Pullman-Standard

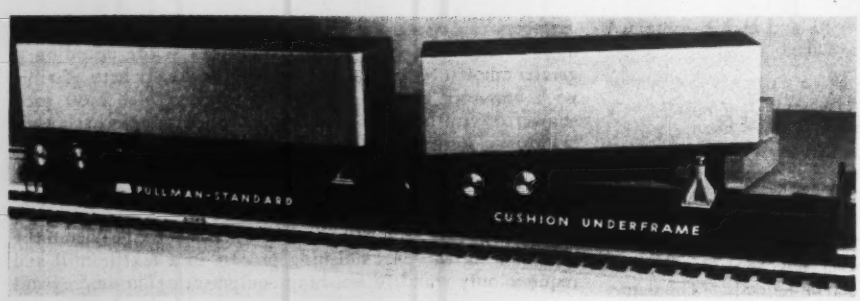


FIG. 2 PULLMAN-STANDARD EXPERIMENTAL MODEL OF A NEW-TYPE CUSHION-UNDERFRAME CAR WITH AUTOMATIC HOLD-DOWN DEVICES AND A LOADING PROCEDURE FOR THE TRANSPORTATION OF TRUCK TRAILERS ON THE RAILROADS

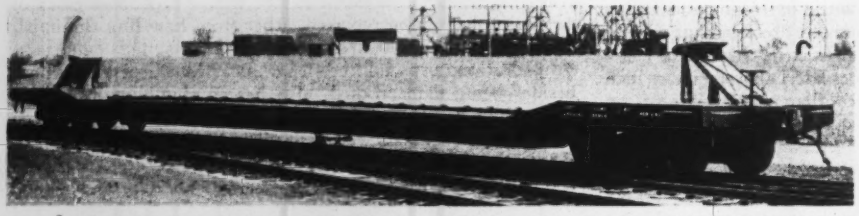


FIG. 3 EXPERIMENTAL TRAILER TRANSPORT CAR, A DEVELOPMENT PROJECT OF THE ELECTRO-MOTIVE DIVISION OF GENERAL MOTORS CORPORATION

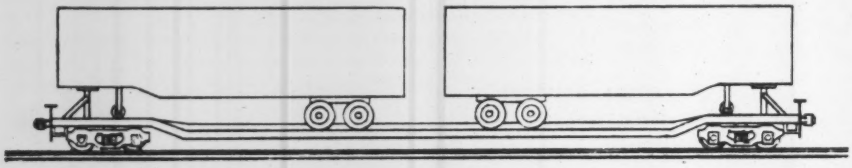


FIG. 4 SKETCH SHOWING G. M. TRAILER TRANSPORT CAR WITH SEMITRAILERS IN POSITION

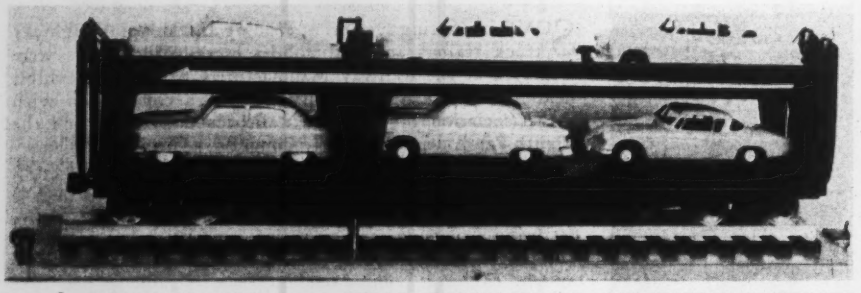


FIG. 5 WORKING MODEL OF SIX-CAR AUTO LOADER DESIGNED AND BUILT BY THE EVANS PRODUCTS COMPANY

model shipping dock. Outgoing trailers are assigned individual trackside lanes at car-deck height and may be delivered and abandoned there by city or local tractors. Arriving trains of flatcars are unloaded in lanes that alternate with the loading lanes. One man operates the power tractor which efficiently unloads and loads, with a second crewman for latching, adjusting, and locking the hold-down devices.

Proposed flatcars are 75 ft long, accommodating two standard cross-country-type trailers of 35 ft each, or three short trailers. Locked down, ready for the rails, each assembly has a center of gravity equivalent to a similarly loaded boxcar, the engineers reported.

Another type of trailer transport car, a development project of the Electro-Motive Division of General Motors Corporation, La Grange, Ill., was also on display. Emphasizing that the car was designed and built for experimental operation only, G.M. engineers pointed out that it is proposed to carry two standard semitrailers up to as long as 35 ft, back to back, side-loaded to the cars on a depressed track or from an elevated platform.

The car, of all welded contruction, is 75 ft long, $9\frac{1}{2}$ ft wide, and has a light weight of 67,000 lb. The depressed center section is 29 in. from the top of the rail and running the length of this depressed section is a raised portion along the center line that is said to improve car strength and prevent side movement of a trailer should it break loose from tie-down devices. Rubber draft gears are used with new-type couplers that inhibit side movement or jackknifing of cars.

Stanchions are provided at either end of the car, embodying a type of fifth-wheel arrangement to engage the kingpin of the trailer. These stanchions are equipped with rubber shock absorbers to permit the trailers to move $4\frac{1}{2}$ in. in each direction longitudinally and thus absorb any shock due to slack action in a train.

Tie-down of the trailer is further provided by a pair of hydraulic struts (shock absorbers) installed on each side adjacent to the trailer wheel. These are applied to control side roll of the trailer body.

The car will be equipped with standard four-wheel high-speed freight trucks equipped with specially designed brake rigging.

Capacity is 120,000 lb and load limit is 139,000 lb.

SIX-CAR AUTO LOADER

A model of a new double-deck auto loader that permits six autos to be carried instead of four, was unveiled by Evans Products Company, Plymouth, Mich. According to Evans the six-car auto loader is expected to be ready for test runs by Oct. 1, 1953.

Three advantages are cited for the new auto loader. First, its pay load will be increased 50 per cent over conventional freight-car auto loads. Second, two railroad cars will be able to do the work of three. Third, through modification of present loading and unloading practices, it is expected the new auto loader will do much to increase revenues for the railroads.

The first auto loader is built on a standard 53-ft 6-in. flatcar and is adaptable to other sizes. Three autos are carried on the floor and three on the second deck. Except for the framework supporting the second tier, the car is entirely open. It can be loaded from either end or either side. Autos are driven aboard. Wide loading entrances make auto loading easy and reduce loading and unloading time.

The first auto is driven up an electrically powered elevating ramp to the second deck; the next two are raised by the powered ramp. The hoist operating the ramp has also been engineered for easy manual operation. The third auto loaded uses the raised ramp as its floor. Then three cars are driven into the lower deck and all are secured against shifting while in transit. When not in use as an auto carrier, the new car can be used to carry many types of freight ordinarily shipped on flatcars.

Two large railroads, one an eastern carrier and the other serving the west, will receive the initial installations for the new six-car auto loader.

Hotbox research

TWO unusual testing machines for use in research on minimizing the occurrence of railroad-freight-car hotboxes have been completed by Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill.

The two-year $275,000 project is sponsored by the Association of American Railroads.

The testing machines include the following:

1 An actual freight-car truck—the assembly containing four wheels at the front or rear of a freight car—which is set up so that cooling, heat flow, and temperature characteristics of the journal can be studied under controlled laboratory conditions. This is said to be the only device of its type in existence. Foundation scientists plan to study how the bearing is cooled and how the cooling action may be improved.

2 A full-scale bearing testing machine, which simulates the workings inside a journal box under controlled laboratory conditions, has been constructed. The tester will be used in measuring frictional resistance of the bearing; fluid pressures; effects of different oils; and characteristics of waste materials used in lubrication.

In explaining the over-all hotbox project, George L. Pigman, project engineer, said, "The journal bearing is a wonderfully simple device for keeping the wheels of a freight car moving.

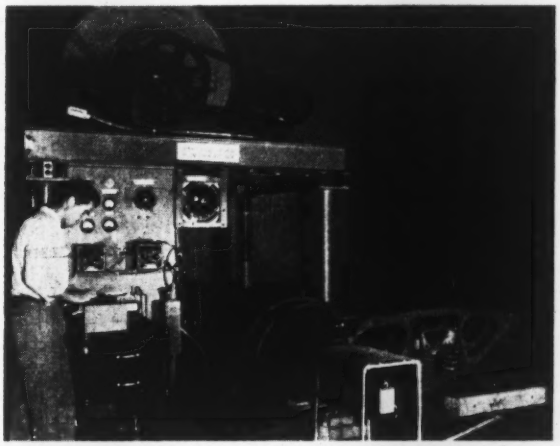


FIG. 6 TEMPERATURE VARIATIONS AND COOLING PROPERTIES OF A RAILROAD FREIGHT-CAR JOURNAL BEARING ARE MEASURED USING FREIGHT-CAR-TRUCK TESTING MACHINE

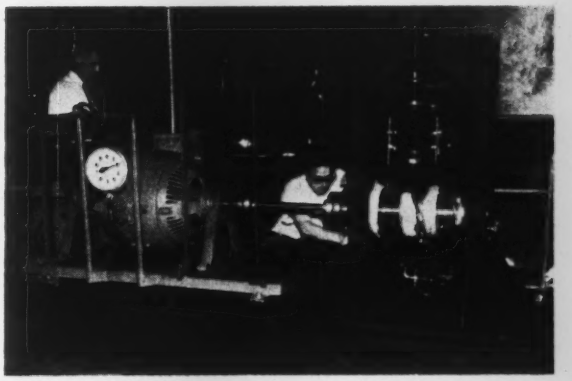


FIG. 7 SPECIAL TEST MACHINE TO STUDY EFFECT OF DIFFERENT OILS AND METHODS OF OIL SUPPLY FOR RAILROAD FREIGHT-CAR JOURNAL BEARINGS

"A survey showed that hotboxes occurred on an average of one for every 331,192 car-miles in March, 1953. That means an imaginary car could have traveled around the earth more than 13 times before developing a hotbox.

"The trouble is, hotboxes do develop, and it always means expensive delays and repairs."

The journal is the part of a freight-car axle that supports the bearing. There are no moving parts in the bearing assembly, except for the rotating journal. An oil-wick system feeds lubricating oil to the journal. When the car is in motion, oil is carried up to surround the journal.

Thus the journal and bearing do not come into actual contact while the car is in motion. In effect, Mr. Pigman said, the freight car rides on a thin layer of oil.

Hotboxes may start when the metal in the journal and in the bearing come into contact while the train is moving, he explained. Heat generated by the friction raises the temperature and can ignite the lubricating oil. If the train keeps moving, the heat grows more intense.

Part of the bearing may melt, Mr. Pigman said. The journal then comes into contact with a brass part of the bearing. As the temperature mounts, the rotating journal destroys the brass bearing.

A dozen scientists and engineers from the Foundation's heat-power, chemistry, metals, dynamics, electrical engineering, and operations research departments worked on the initial phase of the project, a field survey of railroads, and related facilities, to provide information and a practical knowledge of operating conditions.

Some facts the researchers found during the field surveys follow:

1 Performance of journal bearings is considerably better in the fall and spring than during the summer.

2 More stringent inspection, maintenance, and repair will reduce hotboxes.

3 Use of new oil additives may help overcome some lubrication faults. This is being studied.

4 Hotboxes occur most frequently on open-top cars, such as gondolas and hopper cars. Normal usage of these cars involves a higher average load than that for boxcars.

Mr. Pigman said the purpose of the current phase of research is to learn basic principles involved in bearing operations;

limitations of present bearing design features and materials; and practical means for improving bearing performance.

He said the research group also is trying to determine whether a hotbox detector is feasible without requiring installations in the cars.

Titanium Melting Process

THE development of a new titanium melting process which it is claimed produces ingots with superior characteristics to anything presently known and, in addition, increases the "yield" of metallic titanium from its sponge raw material, now in critical short supply, has been announced recently by Mallory-Sharon Titanium Corporation, Niles, Ohio.

Two methods have been used previously by various producers—arc melting and induction melting. Each method had its advantages and disadvantages, and neither was entirely satisfactory; arc-melted ingots are not sufficiently homogeneous, while induction-melted ingots have a carbon content that makes them undesirable for many applications. The new process combines the best features of the two older methods and results of initial production have been highly optimistic, according to engineers and metallurgists of Mallory-Sharon, who developed the process.

PROCESS ADVANTAGES

Advantages of the new melting process, designated as Method "S," are as follows:

1 Ingots are homogeneous and display the same characteristics throughout. Thus there are no variations in a sheet, for example, rolled from a single ingot. Ingots of a given type are reproducible, and the size and shape can be varied over a wide range.

2 Carbon content can be controlled exactly to any amount specified and held as low as the amount inherent in the sponge material. A titanium electrode is used in place of a carbon electrode, and the melting is accomplished in a crucible made of copper, which is water-cooled. Since there is absolutely no carbon contamination, machining and welding characteristics are improved and impact strength is increased.

3 The yield is increased markedly, and more metallic titanium can be produced from a given amount of sponge raw material since scrap loss is reduced. This factor is highly important in view of the high cost of titanium and of the scarcity of sponge, now the limiting factor on titanium production. The government is now granting large loans to expand sponge production, and the new efficient process will help ease the supply problem.

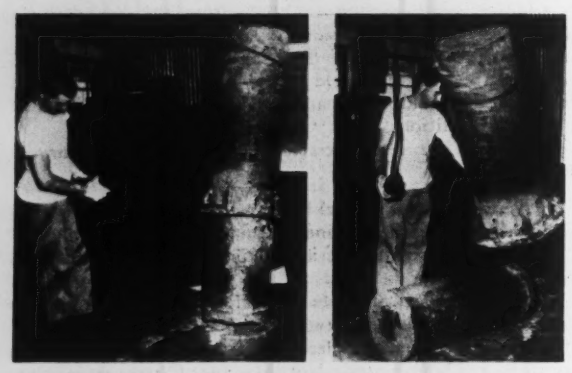


FIG. 8 TITANIUM INGOT BEING DUMPED FROM CRUCIBLE IS HIGHLY HOMOGENEOUS

(Carbon content can be controlled exactly to any amount specified, and held as low as the amount inherent in the sponge material.)

The new melting process is said to be flexible and can be used for a wide variety of alloys. While the bulk of production is now devoted to MST Grade III (commercially pure) light-gage hot-rolled sheet, made by Mallory-Sharon's patented method of rolling, production of MST 3 Al-5 Cr alloy is being increased. This alloy, which is the strongest titanium base alloy now in production, has a tensile strength of approximately 165,000 psi, excellent creep properties, and high strength at elevated temperatures. This alloy, now being used almost exclusively in military aircraft production, now will be more desirable than ever, since carbon can be controlled while homogeneity is improved.

Mallory-Sharon's facilities are being rapidly expanded to meet the rising demand for titanium. Industry production is expanding from 1700 tons, made by all producers in 1952, to an anticipated 18,500 tons by the end of 1956. Mallory-Sharon's present capacity is approximately 1000 tons. The company has made many major contributions to the metallurgy of titanium and has studied and solved many problems in the melting, rolling, and fabricating techniques which are now available to users of titanium.

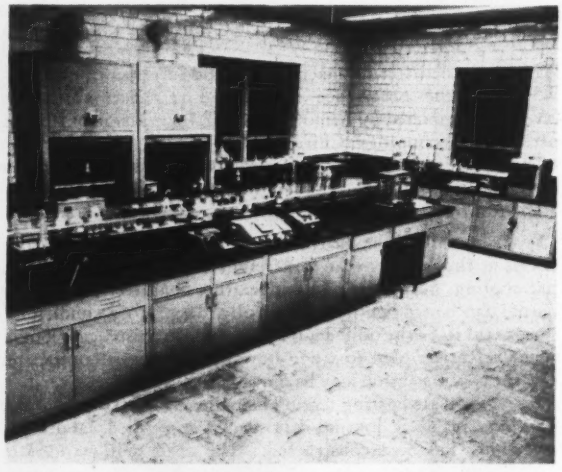


FIG. 9 A PORTION OF THE COMPLETE CHEMICAL LABORATORY FACILITIES IN MALLORY-SHARON'S TITANIUM LABORATORY, WHERE CHEMICAL ANALYSES WILL BE MADE ON ALL PRODUCTION RUNS

TITANIUM LABORATORY DEDICATED

Concurrent with the announcement of its new melting process, Mallory-Sharon dedicated the country's first industrial laboratory to be devoted exclusively to research and development on titanium at Niles.

The new laboratory will be devoted to basic research, development of titanium and titanium alloys, and production testing. It will include a complete chemical laboratory, metallographic and spectrographic equipment, mills for hot-rolling test specimens, furnaces for heat-treating and melting, and an x-ray diffraction unit, in addition to normal laboratory test equipment.

It was pointed out that the completion of the new laboratory permits Mallory-Sharon to concentrate all its activities in one

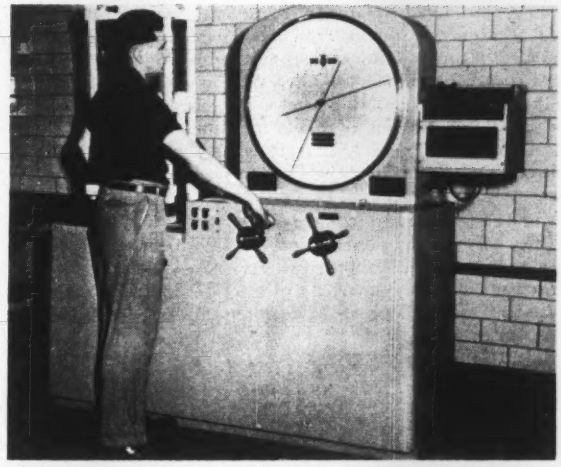


FIG. 10 THIS TESTING MACHINE WILL CHECK TENSILE STRENGTH OF VARIOUS TITANIUM ALLOYS, SUCH AS MALLORY-SHARON'S 3 AL-5CR, THE STRONGEST TITANIUM-BASE ALLOY NOW IN PRODUCTION

location. This is particularly important since current industry practice calls for each piece of titanium produced to be accompanied by a complete chemical and physical analysis. The company's facilities at Niles now include the laboratory, a complete melting shop, and the extensive rolling and fabricating facilities of the Niles Rolling Mill, a division of Sharon Steel Corporation. Mallory-Sharon manufactures titanium and titanium alloys in the form of sheets, strip, plates, and other flat-rolled products, as well as rods, hexagonals, and forgings.

Odor-Pollution Control

HOW a new catalyst—the Oxycat—can end coffee-plant odors and many other pollution problems was demonstrated recently by inventor Eugene J. Houdry, president, Oxy-Catalyst, Inc., Wayne, Pa. Mr. Houdry is a famed pioneer in the catalytic cracking of petroleum. Using the coffee-roasting plant of Eppens, Smith Company, Inc., Long Island City, N. Y., as a plant-size model, Mr. Houdry explained how a bed of Oxycats, installed in the exhaust stack of one of the plant's 14 coffee-roasting ovens, completely oxidizes rank coffee fumes that result from the roasting process.

While several of the plant's exhaust stacks not equipped with the catalyst were emitting dense clouds of acrid coffee smoke and steam, which observers could smell and see, a completely invisible, odorless effluent was issuing from the one stack equipped with the catalyst.

It was reported that the catalyst installation had been on stream at the coffee plant continually for the past month.

During this trial period the catalyst has been completely removing all traces of objectionable coffee odor and smoke that had been a cause of concern to company management. On the basis of this performance, the company plans to equip the remaining 13 coffee roasters with Oxycat beds.

It is estimated that the gas required to remove coffee fumes by incineration would be half as much as that needed to roast the coffee alone. The gas bill for a catalyst installation is only half that for incineration.

The basic Oxycat—a cagelike unit $5^1/_2$ in. long, $3^1/_8$ in. high, and 3 in. wide—is made up of two thick porcelain end-plates, and, between them, a porcelain spacer bar and 73 coated porcelain rods. These Oxycats are stacked, in the required number, side by side and one on top of the other, in the exhaust stacks of furnaces, ovens, incinerators, or power plants.

The Oxycat rods are streamlined. Their tear-drop design minimizes resistance to air flow and exposes a maximum catalyst surface to the moving air stream.

Waste gases flow across the Oxycat rods. Combustion of the gases occurs at the surface of these rods which are coated with a 0.003-in. film of catalytic agent—catalytic alumina and platinum alloy.

Simply, the Oxycat permits the burning of noxious fumes and waste gases at temperatures far below their normal ignition points.

In the process the chemical heat potential of the combustible fumes is released. Stack temperatures may be rasied as much as 1000 deg or more. In general, the catalyst raises stack temperature 55 F for every Btu per cubic foot of exhaust gas.

On the average, one Oxycat can handle from 5 to 20 standard cu ft of exhaust per min. But the exact capacity of the Oxycat varies with concentration of combustibles and the nature of the fumes.

Though demonstrated for the first time in New York in a coffee plant, the Oxycat is capable of removing a wide range of pollutants. It can be used successfully for pollution control and often for profitable waste-heat recovery, wherever combustible gases or fumes are the source of pollution.

For example, in its first use in a metal-finishing plant in Allentown, Pa., the catalyst literally permitted the Enamelstrip Corporation to run on its own smells. For in oxidizing noxious solvent fumes that had been the cause of bitter contention by the

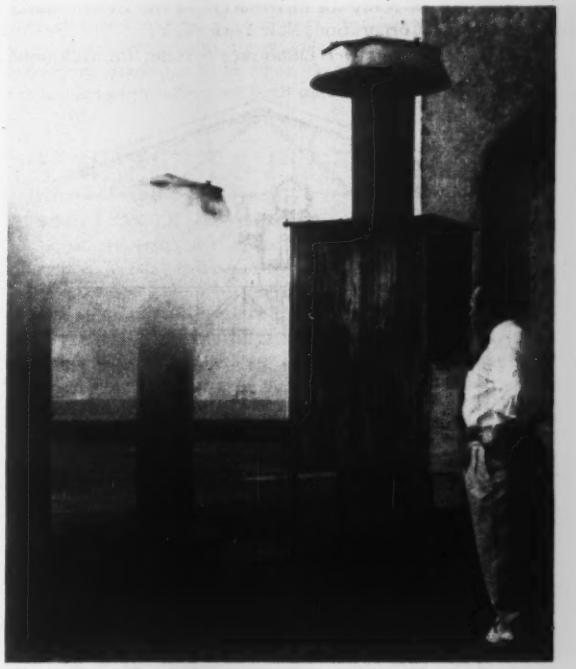


FIG. 11 CATALYST INSTALLATION PREVENTS PLANT ODORS AND OTHER POLLUTION PROBLEMS

(The stack at left—one of 14 like it at Eppens, Smith Co., Inc., coffee-roasting plant—is belching forth a dense blanket of odorous coffee smoke that rises from the plant's coffee roasters below. The stack at right is installed in one of the plant's coffee-roasting lines, too—but a chamber of oxidizing catalysts completely burns off all traces of coffee odor and smoke.)

plant's neighbors, a bed of Oxycats generated enough heat energy to supply 90 per cent of plant fuel needs.

In the petroleum field the Oxycat has been used successfully by Sun Oil Company at its Marcus Hook refinery to recover $27,500 of usable heat energy a year from waste cracking gases, and more recently by the Standard Oil Company of Texas at its El Paso refinery to oxidize the objectionable exhaust from its main petroleum cracking unit, it was reported.

In a case of in-plant pollution, the Radio Corporation of America installed the Oxycat at its Camden, N. J., plant to burn off a thick smoke composed of wax fumes and particles. The acrid wax fumes had been annoying engineers working in the plant's main office building.

At present catalyst beds are being installed in smoky incinerators on the west coast. The catalyst removes smoke, odors, and combustible vapors from incinerator exhausts.

Though the present Oxycat has been used for over two years in industrial plants as a catalytic muffler for removal of carbon monoxide and hydrocarbon fumes from engines running on nonleaded gasoline, Mr. Houdry is now working on catalytic mufflers for diesel and leaded-gasoline engines. When perfected, these units would end a major source of metropolitan air pollution—the hydrocarbons exhausted by city buses and automobiles.

Optical Marking System

AN optical marking system which is currently being used on certain phases of ship construction in a number of European yards is now ready for distribution in the United States by the Ampower Corporation, New York, N. Y.

Known as the Ampower Lumotrace System, the technique was developed in Germany during the last war and permits the optical projection of scale drawings directly and in full size on the material to be fabricated, thus eliminating the traditional and expensive mold-loft procedure now in use throughout most of the world's shipbuilding yards. No longer is there any need for a full-scale layout of the ship's lines on the loft floor, according to Ampower. Lofting with Lumotrace is done to one-tenth scale, although this does place extra demands on maintaining accuracy.

Cumbersome wooden templates, not to mention the problem of their storage and preservation, are said to be eliminated by Lumotrace. Skilled-labor costs are reduced, the chances of error are markedly lowered, production time and material costs are saved, floor space requirements are less, and the over-all degree of accuracy is equal to or better than conventional techniques now in use.

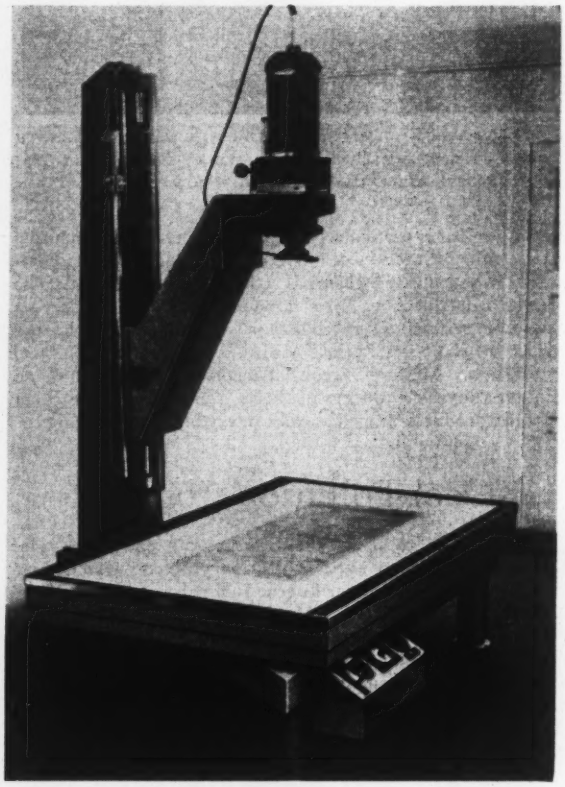


FIG. 13 SPECIAL LUMOTRACE CAMERA FOR REDUCING TEMPLATE DRAWING TO A 4 × 5-IN. GLASS NEGATIVE

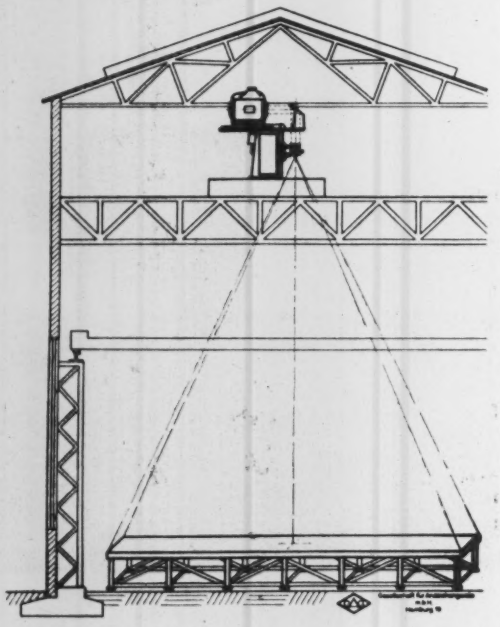


FIG. 12 SCHEMATIC VIEW OF LUMOTRACE PROJECTION SYSTEM

(Draftsman's original drawing is photographed on 4 × 5-in. negative, which is then placed in a remote-controlled projector, above, and beamed down to a 40-ft steel plate located on a worktable about 30 ft below.)

Briefly, the system works as follows: Draftsmen trained in lofting prepare the standard body frames, sections, and lines plans to one-tenth scale. From this they develop the hull-plating dimension drawings to the same scale. These drawings are then photographed on glass negatives, which are placed in a projector and beamed directly on to steel plates. Unskilled workmen then trace this image on the plate and the plate is sent along to be fabricated.

The equipment used in the Ampower Lumotrace system consists primarily of a high-precision camera and optical projector. The camera unit is mounted on a vertical track and points downward to a glass-topped table on which the drawings

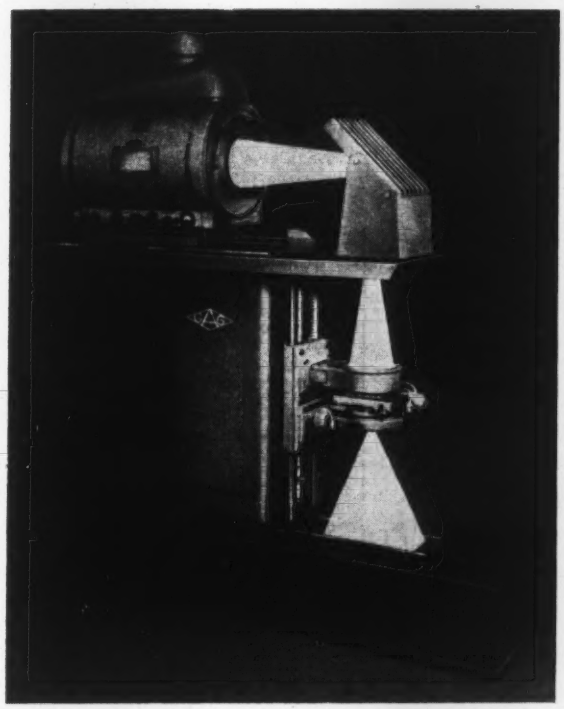


FIG. 14 REMOTE-CONTROLLED PROJECTOR WHICH BEAMS 4 × 5-IN. NEGATIVE TO WORKTABLE ABOUT 30 FT BELOW

FIG. 15 PROJECTED IMAGE AS IT APPEARS ON WORKTABLE BEING MARKED OFF ON STEEL PLATE

to be photographed are placed. The glass top is pressed over the drawings to insure flatness.

The projector is rigidly mounted in a suitable building so that it can be located about 30 ft above a special worktable. It incorporates a powerful arc lamp or, in some installations, a high-intensity mercury lamp. The projected image is of sufficient intensity to make darkening the room to any appreciable degree unnecessary.

A special lens of relatively short focal length enlarges the negative 100 times in lineal dimension or 10,000 times in area and projects the image without distortion directly on to the work surface. The projector is permanently adjusted for definition during assembly and thereafter requires no attention. A remote controller at the worktable allows the projection unit to travel vertically within a range of about 20 in., enabling exact adjustments to be made in the scale factor.

The adjustment is made by matching standard intervals marked on the original drawings with a steel tape containing markings of the same intervals at full scale. The system is said to be so accurate that the projected image of these standard intervals are never out by more than $^{1}/_{16}$ in. over a distance of 40 ft—well within the allowable tolerances for plate marking.

The worktable on which the steel plates are marked is permanently leveled and adjusted during the installation of the Lumotrace system so as not to introduce optical distortion due to errors in the focal plane.

The marking of the plates is accomplished with a hammer and centerpunch, while written instructions are traced with white paint. As no interpretation is required on the part of the marking operator—he just paints along lighted lines—the possibility of error is practically eliminated.

Special drafting instruments are needed to obtain the extreme accuracy required, and all drawings are laid out on a translucent plastic with high dimensional stability. Translucency permits the drawings to be photographed from both sides, so that one drawing suffices for both port and starboard use.

5 Million-Lb Plate Stretcher

A 5 MILLION-LB plate stretcher, said to be the largest and most powerful in the world, is now in operation at the Trentwood, Wash., rolling mill of Kaiser Aluminum & Chemical Corporation. It has the capacity for stretching high-strength aluminum-alloy plate up to 2 in. thick and 40 ft long.

Plate stretched on the huge machine will go primarily to the transportation, chemical, shipbuilding, and aircraft industries. First deliveries of metal processed on the stretcher have been made already.

Through accurately controlled stretching, the machine flattens the plate, relieves residual stresses resulting from rolling and heat-treatment, and develops optimum uniform properties throughout the material. Uniform strain is exerted over the entire plate at one time, as compared with the progressive working of a local area in other flattening methods.

An important result is that metal so processed may be machined with an absolute minimum of distortion. This is of special advantage to aircraft manufacturers who, to an increasing degree, are using machined, integrally stiffened structures such as large wing panels instead of sections fabricated from a large number of pieces.

The stretcher, which is operated hydraulically, is 81 ft in over-all length and 18 ft wide, with a height at its highest point of 9 ft, 2 in. Weight of the big machine is 275 tons. The extreme stretching stroke is 7 ft. See frontispiece, page 772, in this issue.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Industrial Instruments

Automatic Calibration of Transducers, by J. F. Kinkel and R. R. Mawson, Consolidated Engineering Corporation, Pasadena, Calif. 1953 ASME Semi-Annual Meeting paper No. 53—SA-53 (mimeographed).

THE calibration of transducers generally involves the evaluation of two distinct sources of error inherent in the device, according to this paper. The first of these may be described as internal errors resulting from an imperfect response to the measured stimulus. The second may be described as external errors resulting from response to environmental conditions or stimuli other than the one to be measured. In addition, the response to the measured stimulus, and hence the internal errors, may be a function of environment. Furthermore, all sources of error are generally a function of the previous history of the transducer.

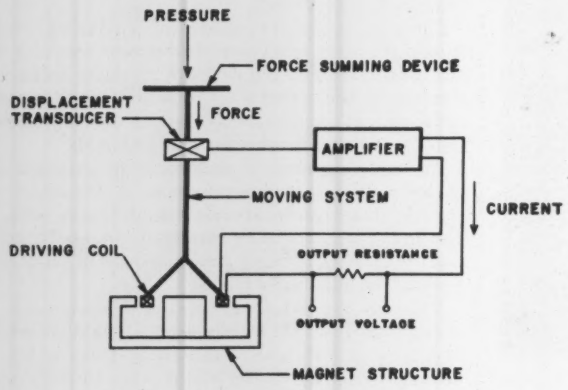
A pressure pickup, for example, has internal errors expressed as nonlinearity, hysteresis, set, and drift, all of which are functions of the environment and history of the pickup. External errors will result from response to changes in temperature and acceleration.

The paper describes a system of automatically calibrating pressure, force, and acceleration transducers to an accuracy of 0.1 per cent over a large temperature range. The system relies on the dynamic-force-balance principle for its pressure, force, or acceleration reference and includes either analog or digital presentation of the data.

Most of the operational experience with the subject system has been in developmental and pilot-production test of Consolidated's Type 4-310 transducer.

The principal result of this test method has been the very substantial reduction of test time required and the increased accuracy of the test. Formerly, an average of 1.1 man-days was required to completely test one pickup, whereas by this automatic means the equivalent test is performed in 0.15 man-day.

A secondary result of this type of operation is in reality of no less import than the time factor. Most transducers exhibit to some degree a phenomenon known as "output drift," which is simply a change of output reading with time for a given constant input. This phenomenon is at least analogous to, if not directly associated with, "creep" in stressed metals. Since the "time constant" of this phenomenon is generally short compared to the time required for manual calibration by conventional methods, frequently errors due to output drift are obscured in the data. The higher-speed capabilities of the automatic calibration system have revealed many new aspects of this output drift problem and have provided the means whereby steps for the elimination of this error can be undertaken.



DESCRIPTIVE DIAGRAM OF PRESSURE BALANCE

How to Order ASME Papers

COPIES of ASME technical papers digested in this section are available until supply is exhausted, at 25c each to members; 50c to nonmembers.

Acceptable methods of payment are by check, U. S. postage stamps, free coupons[1] supplied to every ASME member, and purchased coupons—ten of which a member may buy for $2 and a nonmember for $4.

When ordering, please give paper number, its title, author's name, and quantity wanted; or use order form.

Orders should be addressed: ASME Order Department, 29 West 39th Street, New York 18, N. Y.

[1] **By the July 23, 1953, action of the Council, all ASME members are to receive ten free coupons annually which they may use to acquire technical papers presented at ASME meetings. The first sets of free coupons were mailed to members in August, 1953.**

NOTE: No digests are made of ASME papers published in full or condensed form in other sections of MECHANICAL ENGINEERING.

ASME publications and advance copies of ASME technical papers are on file in the Engineering Societies Library and are indexed by the Engineering Index, Inc., both at 29 West 39th Street, New York, N. Y.

ASME Transactions and the *Journal of Applied Mechanics* are on file in the main public libraries of large industrial cities and in the technical libraries of engineering colleges having ASME Student Branches.

ASME Order Department
29 W. 39th St., New York 18, N. Y.

Date.....

Please send me the papers indicated by the following circled numbers:

53—SA-1	53—SA-45	53—SA-65
53—SA-16	53—SA-46	53—SA-66
53—SA-17	53—SA-47	53—SA-67
53—SA-23	53—SA-48	53—SA-73
53—SA-24	53—SA-49	53—SA-83
53—SA-25	53—SA-50	53—SA-84
53—SA-26	53—SA-51	53—APM-2
53—SA-29	53—SA-53	53—APM-4
53—SA-30	53—SA-55	53—APM-5
53—SA-34	53—SA-57	53—APM-6
53—SA-36	53—SA-58	53—APM-8
53—SA-37	53—SA-60	53—APM-9
53—SA-40	53—SA-61	53—APM-11
53—SA-42	53—SA-62	53—APM-12
53—SA-43	53—SA-63	53—APM-15
53—SA-44	53—SA-64	53—APM-16
	53—APM-25	

Name.....

Address.....

☐Remittance enclosed ☐Bill me

☐ASME Mem. ☐Nonmem.

The Oscar—A New Approach to the Analysis of Oscillographic Records, by Bernard S. Benson, Benson-Lehner Corporation, Los Angeles, Calif. 1953 ASME Semi-Annual Meeting paper No. 53—SA-50 (mimeographed).

THIS paper describes a new approach to the problem of the analysis of oscillographic records. It also describes the Oscar, a machine which has been designed and built to implement the solution to the problem.

Briefly, the problem is as follows: The design of measuring and recording systems imposes certain limitations on the presentation of the output data which these systems produce. These restrictions are, for example, in terms of physical sizes, scales, relative position of traces, and other criteria. On the other hand, the design characteristics of the human being also impose limitations on the required presentation of the input data to the observer in terms of his technique for observation, his frames of reference, and other factors. In the sense that the system output and the required observer input differ, the data can be considered to be coded. This is not a completely unintelligible code by any means, but a partial code, inasmuch as certain information is contained in the record but is not meaningful to the observer.

The Oscar can be considered to be a decoder since it is designed to convert the recording-system output, in this case an oscillographic record, to an acceptable observer input, in this case data plotted and tabulated to required scales. In the design of machines of this type, there is an optimum distribution of participation between the machine and the operator in order that the cost of the over-all operation should be minimized. One tries to solve the problem with the least complexity in the equipment and with the least demand on the observer in terms of mental gymnastics.

Application of Magnetic Recording to Flight Instrumentation, by M. J. Stolaroff, Ampex Electric Corporation, Redwood City, Calif. 1953 ASME Semi-Annual Meeting paper No. 53—SA-64 (mimeographed).

THIS paper points out that rapid advances in the art of magnetic recording during the past two years will help solve one of today's biggest problems of flight instrumentation tests—the handling of tremendous quantities of data accumulated.

Often flight tests may last for several hours and as many as 100 channels of information are gathered. By recording on magnetic tape, the data is reproducible in electrical form and may be automatically reduced and analyzed. The recorded tapes are played back, electrical signals can be recorded into digital form, as desired, and fed into high-speed electronic computers, card-punch computers, or into high-speed printers or plotting boards for automatic read-out. Such handling of data results in saving thousands of man-hours and makes it available within a short time after flight tests.

In the past two years the frequency range of recorders has been extended, and recording systems have been developed which allow accurate recording and reproduction independent of tape characteristics. Improvements in transport mechanisms allow accurate data to be taken under shock and vibration.

At the present time there are two different systems of magnetic recording which can be applied to airborne applications. One employs direct recording and results in a system compatible with recordings made of telemetering data, which is now widely used on all of the government missile test ranges, and by many missile contractors. This system allows recording of a large number of channels on a single track of the tape recorder, the various channels being dispersed over the frequency spectrum.

The second system employs the use of an FM carrier system to convert the input data into FM form and records it on the tape in this manner. This system requires a separate track on the tape for each channel of information, but it provides a five-to-one improvement in accuracy over the previous system.

Future developments along these lines, to solve specific problems met in airborne recording, will be in the direction of packaging, making equipment more flexible and compact, with lower weight and power requirements.

Multichannel Dynamic Recording—A Powerful Tool for the Design Engineer, by W. T. Young and John Tarbox, Consolidated Engineering Corporation, Pasadena, Calif. 1953 ASME Semi-Annual Meeting paper No. 53—SA-49 (mimeographed).

A BRIEF survey of the field of indicating and recording instrumentation, with particular reference to the part that multichannel galvanometer-type recording oscillographs play in design testing and evaluation is presented. A careful study of the diametrically opposed trends toward specialized instruments and basic general-purpose wide-range instrumentation is discussed. Typical applications to design problems are shown. Two new recording oscillographs, still in the design phase, are presented to illustrate trends in precision-instrument design.

The general limits of each basic type are defined in terms of results obtained rather than details of construction. Much of the material is not suitable for exact mathematical analysis and evaluation. Therefore the approach and the presentation is subjective and somewhat informal.

Heat Transfer

Heat Transfer to Constant-Property Laminar Boundary-Layer Wedge-Flows With Stepwise and Arbitrary Wall-Temperature Variation, by Steve Scesa, Jun. ASME, and Solomon Levy, University of California, Berkeley, Calif. 1953 ASME Semi-Annual Meeting paper No. 53—SA-47 (mimeographed; to be published in Trans. ASME).

THE analysis for the determination of the heat transfer for bodies in constant-property two-dimensional laminar flow with a free-stream velocity variation as $u_1 = Kx^m$ and a stepwise wall-temperature variation is presented in this paper. The general theory may be applied to a gas of any Prandtl number although numerical results have been computed herein for Prandtl numbers of 0.7 and 1 for the values of m equal to $-1/3$, 0, $1/9$, $1/3$, 1, and 4. The method of investigation is such that the temperature profile may be obtained if so desired. Results of local Nusselt number are compared with the more approximate investigations of Bond and Lighthill which indicate an increasing deviation as m increases or decreases from zero. However, comparison of the ratio of the local Nusselt number with an arbitrary wall-temperature variation to the local Nusselt number for a constant wall temperature indicates good agreement with the results of Bond and Lighthill.

Extension to the problem of an arbitrary wall-temperature variation is indicated. The theoretical investigation neglects the effect of heat generated by friction since this effect may be considered by superposition of proper solutions.

Forced Convection From Nonisothermal Surfaces, by John Klein and Myron Tribus, Jun. ASME, University of Michigan, Ann Arbor, Mich. 1953 ASME Semi-Annual Meeting paper No. 53—SA-46 (mimeographed).

THE convection of heat from surfaces at nonuniform temperatures is reviewed in this paper. Solutions for systems previously analyzed by others are collected and compared. A few new solutions are proposed. A method of treating heat

fluxes with variable wall temperature by using the solutions for constant wall temperature is described.

The Design of Wet Air-to-Air Heat Exchangers, by James M. Appelgate, AiResearch Manufacturing Co., Los Angeles, Calif. 1953 ASME Semi-Annual Meeting paper No. 53—SA-45 (mimeographed).

THE design of heat exchangers where either evaporation or condensation is taking place on one or both sides of the apparatus does not lend itself to the usual methods of calculation. Varying effective specific heats of the flowing fluids as well as varying heat-transmission coefficients complicate the problem. There is no simple relationship expressing the mean temperature difference in the apparatus.

This paper outlines a method of computing the required surface area for wet air-to-air heat exchangers by the graphical integration of a temperature-enthalpy plot of the flowing fluids. A discussion of the determination of over-all heat-transfer coefficients for crossflow single or multipass heat exchangers is included. A sample problem is given as well as a description of several wet heat-exchanger applications. The use of a Mollier-type psychrometric chart, which is of particular aid in this type of problem, is explained.

Steady-Temperature Fields in Electrical Coils by Membrane Analogy, by Paul J. Schneider and Ali B. Cambel, Jun. ASME, State University of Iowa, Iowa City, Iowa. 1953 ASME Semi-Annual Meeting paper No. 53—SA-43 (mimeographed).

THE theory and application of membrane analogy for the experimental solution of steady-state temperature distributions in electrical coils is presented in this paper. The principal results of the study are the following:

1 An exact mathematical analogy is established between the deflection of a dilated membrane on a closed boundary and the steady temperature at corresponding points in the region within these boundaries, the region being of constant thermal conductivity and generating uniform heat.

2 An approximate relation is established between the deflection of a dilated membrane and this temperature field for the general case where this internal-heat generation is a linear function of local temperature. The approximation is shown to depend on the strength of this heat source, or the magnitude of its variation with local temperature. For moderate or nearly uniform heat development, theory shows that the approximation is close, while for strong or excessively nonuniform heat development, the approximation becomes increasingly crude.

3 A simple method is developed for evaluating the ratio of the membrane dilation pressure to the membrane coefficient of surface tension which is needed for the interpretation of membrane deflections as corresponding field temperatures.

4 Experimental membrane solutions for these temperature fields are obtained for a number of simple electrical coil profile shapes. These solutions are shown to be in close agreement with exact values obtained through particular solutions of generalized analytical formulas.

5 The average order of accuracy using the exact analogic relation for uniform Joulean heat development is approximately ±2 per cent. Using the approximate analogic relation for nonuniform heat development gives approximately the same order of accuracy, although the error is always a positive one. That is to say, that membrane solutions for moderate nonuniform heating tend to be on the safe side by slightly underestimating the admissible electrical loading for the coil.

A Summary of NACA Research on Heat Transfer and Friction for Air Flowing Through Tube With Large Temperature Difference, by Benjamin Pinkel, Mem. ASME, National Advisory Committee for Aeronautics, Lewis Flight Propulsion Laboratory, Cleveland, Ohio. 1953 ASME Semi-Annual Meeting paper No. 53—SA-34 (mimeographed; to be published in Trans. ASME).

THE results of experimental and analytical studies performed at the NACA to determine the heat-transfer and friction coefficients for the flow of air through tubes with large difference in temperature between tube wall and air, (*a*) for smooth tubes of circular cross section; (*b*) for tubes of noncircular cross-sectional shapes; and (*c*) for tubes with various degrees of surface roughness, are summarized.

The experiments for the smooth tubes of circular cross section cover a range of tube-wall temperature from 535 R to 3050 R, inlet-air temperature from 535 R to 1500 R, Reynolds numbers from 1000 to 500,000, exit Mach numbers up to 1, and tube length-to-diameter ratios from 15 to 120. Methods of correlating these data are discussed.

The tubes of noncircular cross-sectional shape, namely, (*a*) square, (*b*) rectangular, and (*c*) triangular, were investigated at tube wall-to-air temperature differences up to 1200 F and Reynolds numbers between 2500 and 250,000. Three degrees of surface roughness, obtained by machining square threads into the inner surface of the tube, were investigated for temperature differences between the air and tube wall up to 1500 F and Reynolds numbers from 1000 to 350,000.

It was concluded that:

1 For heat transfer between a tube wall and air flowing through it, the evaluation of the density, viscosity, specific heat, and thermal conductivity at the film temperature (the mean of the average fluid temperature and tube-wall temperature) in a Nusselt-type correlation results in good correlation of the data in the turbulent-flow regime even for large differences between the tube wall and the air temperature.

2 Evaluation of the fluid properties at the film temperature improves the correlation of the friction data for large variations in the tube wall-to-air temperature difference. However, further refinement of the correlation in the region approaching the transition would be desirable.

3 The equations for heat transfer and friction for the smooth tube were extended to cover the rough-tube data by the introduction of a roughness parameter.

4 The methods used in correlating the data for the tubes of circular cross section for large temperature difference also gave good correlation of the data for the tubes of noncircular cross section. The experimental results of the difference between the corner temperatures and the mean tube-wall temperatures were in reasonable agreement with the results obtained by analytical methods.

Remarks on Film Condensation With Turbulent Flow, by R. A. Seban, Mem. ASME, University of California, Berkeley, Calif. 1953 ASME Semi-Annual Meeting paper No. 53—SA-44 (mimeographed; to be published in Trans. ASME).

ANALOGY calculations of the Prandtl-Kármán type are applied to the film condensation of a pure substance on a vertical wall under such conditions that the flow in the condensate layer is turbulent in this paper. The results agree with Colburn's predictions made by the use of his analogy, which predictions are in general agreement with the meager experimental data available.

The present results are extended to condensates of low Prandtl number, such as molten metals, and, as has been demonstrated already for the case of flow in closed channels, the contribution of

turbulence in this case is found to be small until high Reynolds numbers are attained. Results for the mean heat-transfer coefficient are presented for Prandtl numbers from 0 to 5 and for Reynolds numbers as high as 10^5.

Transient Thermal Stresses in Circular Disks and Cylinders, by G. Horvay, Mem. ASME, Knolls Atomic Power Laboratory, Schenectady, N. Y. 1953 ASME Semi-Annual Meeting paper No. **53—SA-51** (in type; to be published in Trans. ASME).

THE effect of a suddenly applied peripheral temperature

$$\vartheta(R, \varphi, z, t) = T \cos n\varphi \, 1(t)$$

upon circular disks and cylinders is considered in this paper. The most interesting results are (*a*) for thermal shock (t = very small) the stresses in an unrestrained cylinder are

$$\varphi\varphi \sim zz \sim -\frac{E\alpha T}{1-\mu} (r/R)^{R/\sqrt{\pi t}} \cos n\varphi$$

and all other stresses vanish; (*b*) in the steady state ($t = \infty$) the temperature distribution is

$$\vartheta(r, \varphi) = T(r/R)^n \cos n\varphi$$

and all stresses vanish.

Intermittent Heating of Airfoils for Ice Protection Utilizing Hot Air, by H. H. Hauger, Jr., Jun. ASME, Douglas Aircraft Company, Inc., Santa Monica, Calif. 1953 ASME Semi-Annual Meeting paper No. **53—SA-42** (mimeographed).

AN investigation into the fundamental transient heat-transfer characteristics of the airfoil leading-edge double-skin configuration when heated intermittently by hot air for ice protection was undertaken on an electrical analog computer. This problem is distinctive from other problems usually solved by such a computer in that an electrical input circuit had to be designed which would correctly account for the heat balance as the air passes chordwise through the double-skin passages. Also, a combination of electrical networks was devised which would satisfactorily take into account the thermal resistance and capacitance of the growing layers of ice. This research reveals the effect on the de-icing ability of the double-skin design of variables deemed to be important in such a study. The feasibility of such an ice-protection system is attested, and the compromises inherent in the cyclic use of hot air are determined.

Fuels

Smokeless Burning of Waste Process Gases, by Robert D. Reed, Mem. ASME, John Zink Company, Tulsa, Okla. 1953 ASME Semi-Annual Meeting paper No. **53—SA-29** (mimeographed; to be published in Trans. ASME).

SMOKELESS burning of huge quantities of gases presents some serious problems. That the solution of these problems is difficult is shown in the many approaches to the problem of smokeless burning and the indifferent success of most of today's burning devices. Some do very well burning small quantities of gas but fail badly when larger quantities are delivered for disposal. Others fail to continue to burn. Some have proved quite successful.

According to the paper, the facility of burning of hydrocarbons is in direct ratio to the weight percentage of hydrogen to the weight percentage of carbon. A hydrocarbon such as methane having an H/C ratio by weight of 0.33, burns in the open air with little if any smoke. Acetylene having an H/C ratio by weight of 0.083 burns in the open air with an intensely smoky, sooty flame. While these citations literally cover from "pole to pole," it is fair to say that intermediate compounds follow the rule.

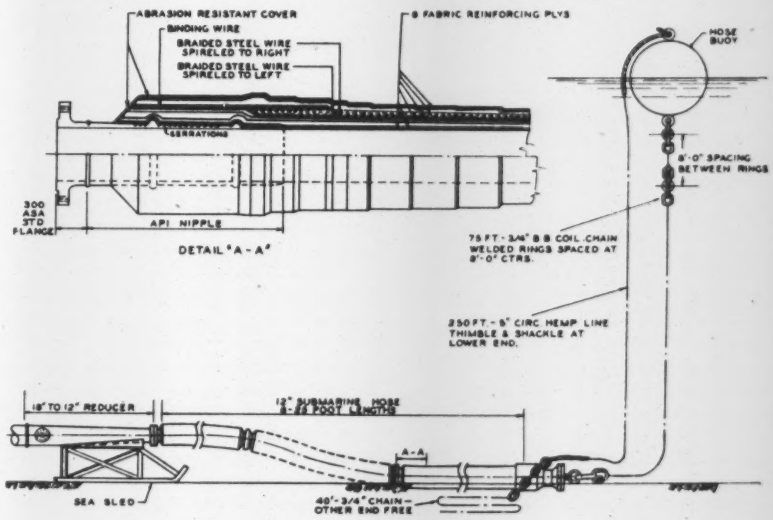
Burning gases to produce a yellow-luminous flame is indicative of two conditions. The first is that the hydrocarbon molecule is being cracked to permit free carbon to be present in the flame. The second is that burning is by diffusion or in absence of turbulence. The latter may be qualified to provide that the state of turbulence is not great enough provided that oxygen is available at the envelope of the flame. The production of black smoke as the result of burning gas requires yellow-luminous flames.

Blue-flame burning is not productive of smoke. Blue-flame burning is indicated for elimination of smoke but blue-flame burning is very hard to get with large quantities of gas.

The paper covers blue-flame burning, injection methods, field flares, corrosion elimination, pilot ignition, heat radiation, and the presence of liquid in flared gas streams.

Offshore Deliveries of Fuel Oil From Tankships Through a Submarine Line to Moss Landing Steam Plant, by S. F. Johnson, Standard Oil Company of California, San Francisco, Calif., and E. A. Salo, Mem. ASME, Pacific Gas & Electric Company, San Francisco, Calif. 1953 ASME Semi-Annual Meeting paper No. **53—SA-30** (mimeographed).

THE location and capacity of the Moss Landing Steam Plant made it desirable to provide for deliveries of fuel oil of the highest commercial viscosity from large tankships through a submarine pipe line approximately $1\frac{1}{4}$ miles long to the storage tanks of the plant. The use of submarine lines is not new, but the type of application involved several unknowns for which there was very little prior experience. In this paper the economic size of the line is discussed in some detail, and experiences in the displacement of cold oil and test data relating to higher viscosity oils are presented. Other features covered are the radio-communica-


ABRASION RESISTANT COVER
BINDING WIRE
BRAIDED STEEL WIRE SPIRELED TO RIGHT
BRAIDED STEEL WIRE SPIRELED TO LEFT
8 FABRIC REINFORCING PLYS
SERRATIONS
300 ASA STD FLANGE
API NIPPLE
DETAIL "A-A"
HOSE BUOY
8'-0" SPACING BETWEEN RINGS
75 FT - 3/4" B.B. COIL CHAIN WELDED RINGS SPACED AT 8'-0" CTRS.
250 FT - 5" CIRC. HEMP LINE THIMBLE & SHACKLE AT LOWER END.
18" TO 12" REDUCER
12" SUBMARINE HOSE
A-A
SEA SLED
40'-3/4" CHAIN - OTHER END FREE

SUBMARINE HOSE DETAILS

tion facilities, the cathodic protection of the buried line, and the general maintenance problems.

The submarine fuel-unloading facility described combines features of reliability, ease of operation, economy of time and manpower that make it worthy of consideration for oil-fuel plants near deep water, the paper states. Some of the doubtful factors, such as the time to remove cold plugs and the need for recirculation, have proved far less onerous than anticipated.

The design used at Moss Landing incorporates margins sufficient to make the unloading time dependent almost entirely on the capacity of the pumps on the ships that so far have delivered oil. The operations corroborate the design estimate that little if anything would be gained by the use of larger-diameter piping.

It is the authors' belief that the Moss Landing arrangement can handle fuel oil of viscosity as high as 300 SSF at 122 F without difficulty.

Lubrication

On the Solution of the Reynolds Equation for Slider-Bearing Lubrication—VII The Nonsteady-State Operation of Tilting-Pad Slider Bearings, by F. Osterle, Jun. ASME, A. Charnes, and E. Saibel, Mem. ASME, Carnegie Institute of Technology, Pittsburgh, Pa. 1953 ASME Semi-Annual Meeting paper No. 53—SA-1 (in type; to be published in Trans. ASME).

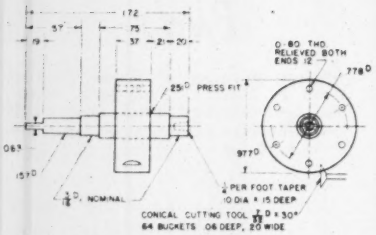
THE Reynolds equation in hydrodynamic-lubrication theory, modified to take into account nonsteady-state effects, is applied to the problem of the tilting-pad slider bearing subject to a sinusoidal pivot oscillation in the direction normal to the bearing surface.

Relationships are developed giving the load-supporting capacity and coefficient of friction as function of the amplitude and frequency of the oscillation.

The Dynamics and Lubrication of a Miniature Turbine Rotor on Porous Bushings, by George Sines, University of California, Los Angeles, Calif. 1953 ASME Semi-Annual Meeting paper No. 53—SA-36 (mimeographed).

IN recent years there has been increased use of small motors, generators, turbines, and similar devices that run at high angular velocities (20,000 to 100,000 rpm). The bearings for these devices present a critical design problem. They must withstand high velocities, and the occurrence of vibration may complicate the problem further.

A miniature air turbine was designed to investigate the lubrication and dynamic action of the rotor shaft within the bearing clearance. An optical apparatus was used to observe the time-position history of the shaft. Several different mechanisms of lubrication were identified at various speeds. At higher speeds boundary lubrication may occur. Under certain conditions the shaft moves in a very irregular pattern characterized by low friction and long bearing life. The conditions for the onset of this motion are discussed.



TEST-TURBINE ROTOR

In applications where dynamic loading of the device is undesirable or where the motion of the rotor within the bearing clearance would impair operation, it may be possible to suppress the transition to vibratory motion by:

1 Using a very precisely balanced rotor.

2 Using a lubricant having a low coefficient of friction in boundary lubrication.

If the slight motion of the shaft in the bearing clearance and the resultant dynamic forces are not objectionable, the erratic orbital motion is desirable because of the low friction and long life demonstrated in the experiments. It is shown that for this type of motion it is necessary to have:

1 Rotor sufficiently balanced.

2 Clearance sufficiently large, dependent on the degree of rotor balance obtainable.

3 A good boundary lubricant to prevent failure of the lubrication.

It was observed that boundary lubrication occurred during several modes of operation. Therefore it is desirable to have a lubricant that forms a tenacious bond to the surfaces. It also is desirable to have a lubricant with a low coefficient of friction. This is desirable not only to reduce the torque required to drive the turbine, but to keep the heat produced in the bearing at a minimum, for the strength of the lubricating layer is less at higher temperatures.

Bearings should be in precise mechanical alignment. However, if mechanical alignment, mechanical processes, or the design requirement prevent it, self-aligning mountings possibly may be satisfactory, the paper states.

Management

The Work-Sampling Technique, by A. J. Rowe, Jun. ASME, University of California, Los Angeles, Calif. 1953 ASME Semi-Annual Meeting paper No. 53—SA-55 (mimeographed; to be published in Trans. ASME).

MANY techniques are currently used for the measurement of factory work. These techniques include stop-watch studies, interruption studies, production studies, occurrence-type studies, predetermined elemental time systems (such as methods—time-measurement), and work-sampling studies (which are often called ratio-delay studies).

Work sampling, as the name implies, is a statistical sampling procedure for obtaining information about industrial activities. The principles are well developed since they are essentially the same as any other sampling technique. This paper elaborates on the application of the basic principles to the measurement of factory activities.

Work sampling is based on the principles of statistical theory. Therefore the maximum usefulness will be achieved when the sampling is done properly and the results interpreted using statistical theory. Little technical knowledge is required to collect the data, but the proper analytical technique should be employed when using the data for predictive purposes. If the data are improperly used, unreliable estimates could result and the application would be costly and inequitable to the workers.

This paper discusses the methodology necessary to take a study properly. Some of the statistical implications are shown in an attempt to promote a thorough understanding of why the sampling should be carried out as indicated.

If random sampling is employed, and long delays are recorded as they occur, the estimate of the per cent delay time will be reliable. However, the standard error or variation of the per cent down time is dependent on the type of underlying distribution. The binomial distribution will be only an approximation. However, the binomial may be used to estimate the standard error when it is shown to fit the data by a Chi Square test.

The work-sampling technique is an analytical approach to the problem of measuring the per cent delay time. This is more desirable than the use of unaided judgment, or arbitrary decisions as to the amount of allowance to provide for unavoidable delays.

Metal Processing

The Friction Terms in Metal Cutting, by W. C. Leone, Jun. ASME, and Edward Saibel, Mem. ASME, Carnegie Institute of Technology, Pittsburgh, Pa. 1953 ASME Semi-Annual Meeting paper No. **53—SA-16** (in type; to be published in Trans. ASME).

THE paper presents the results of an investigation of the friction terms in metal cutting. The so-called "machining constant" is shown to be related directly to the coefficient of internal friction and to vary with the conditions of cutting. The coefficients of external and internal friction appear to be related to the thermal number, and these relationships seem to be quite similar.

Predicting the Angle of Chip Flow for Single-Point Cutting Tools, by L. V. Colwell, Mem. ASME, University of Michigan, Ann Arbor, Mich. 1953 ASME Semi-Annual Meeting paper No. **53—SA-17** (in type; to be published in Trans. ASME).

CURRENT practice for predicting tool life is entirely empirical. Consequently, a prohibitive number of tests must be conducted in order to take all influential factors into consideration in predicting tool performance for a specific set of cutting conditions. One of these factors is the direction of chip flow across the tool face. This determines the effective rake angle which in turn affects the tool life.

The usefulness and application of present tool-life data and that to be obtained will be greatly expanded if they can be correlated with the rake angle in the direction of chip flow. However, such a correlation, once established, will be useful only if it is possible to predict the direction of chip flow for a given tool used with any combination of cutting conditions.

This paper presents a method for predicting the direction of chip flow over a range of tool shape and cutting conditions, thus establishing a necessary basis for the successful completion of the second phase of the over-all objective.

Machine Design

Twisting of Flexible Shafts, by K. E. Bishopp, Illinois Institute of Technology, Chicago, Ill., and D. C. Drucker, Mem. ASME, Brown University, Providence, R. I. 1953 ASME Semi-Annual Meeting paper No. **53—SA-63** (mimeographed).

AN approximate method of analysis and design of flexible shafts is developed and checked against an almost exact theory.

It is found that, once the clearance between the wire layers has been taken up, a major contribution to the torsional flexibility (deflection factor) of the shaft is the deformation occurring between the wires at their points of contact. The stretching of the wires also contributes to the flexibility, but often to a smaller extent.

The effects of twisting a straight flexible shaft which remains so during application of torque are analyzed.

Methods Used in Investigating Gear-Tooth Loading in the Colmol, by James A. Flint, Mem. ASME, The Jeffrey Manufacturing Company, Columbus, Ohio. 1953 ASME Semi-Annual Meeting paper No. **53—SA-62** (mimeographed).

SEVERAL failures in the field of a power-input pinion in the low-head gear train of the Colmol, notwithstanding design calculations to the contrary, prompted setting up one of these machines in the laboratory and simulating field conditions. The necessary instrumentation to actually measure the gear-teeth loading was then laid out.

This paper discusses the failure in the field of this critical gear pinion and the methods used in the laboratory to determine the loading. It contains a description of the machine, the instrumentation used on the test, and the theory and a description of the calculations used to check and evaluate the test data.

Due to the extreme space limitations which are always present in the designing of underground mining equipment it was impossible to suggest putting in a new pinion twice as big, etc. The actual recommendation was to change from spur gears to spiral gears and to increase the number of teeth in the power input pinion from 17 to 21 with a corresponding increase in the number of teeth in the mating gear so that the ratio was unchanged. This, by careful layout, could be accomplished without change in the external dimensions of the gearboxes.

Metals Engineering

Mechanical Aspect of Seizing in Metal Wear, by Harry Czyzewski, Metallurgical Engineers, Inc., Portland, Ore. 1953 ASME Semi-Annual Meeting paper No. **53—SA-26** (mimeographed).

THIS paper presents the mechanical aspect of seizing in metal wear which accounts in a qualitative manner for the observed phenomena in accelerated mechanical abrasion. The mechanical analysis also explains the failure of externally lubricated alloys to equal the performance of self-lubricated alloys.

According to the paper, the most widely accepted metal characteristic to reduce the tendency for galling is self-lubrication. Self-lubrication is exemplified by porous powder metals (oil-impregnated), gray cast irons and graphitic steels (graphite-lubricated), and leaded bronzes (lead-lubricated). The mechanical aspect of seizing provides an additional reason for the success of self-lubricated metals which is suggested to account for the failure of externally lubricated metals to equal self-lubricated metals in resistance to seizing.

Thus the facts that self-lubricated alloys are known to have a greater resistance to incipience of galling and to have a lower extent of damage from galling, are accounted for in the mechanical aspect of accelerated mechanical abrasion. On this basis, porous alloys without a lubricating agent would be expected to gall less than nonporous alloys, also unlubricated.

The mechanical interpretation of accelerated mechanical abrasion would provide a principle upon which to design surfaces of "engineered roughness." It is evident that the roughness must be on a scale comparable with the asperity size, i.e., the microscopic scale. Many instances of the significance of such engineered roughness are known in practice. The importance of graphite-flake size, shape, and distribution in gray cast-iron applications is well known. From the standpoint of self-lubrication, the dimensions of the "lubricant reservoir" would not be too critical. Yet, in practice, the graphite-flake classification is controlled closely for such parts as piston rings, cylinders, and other wearing-surface applications.

Investigations on the gall resistance of ductile iron as compared to flake gray iron revealed that for equal graphite contents and similar matrix structures, the gall resistance of the flake-graphite iron was superior to that of the ductile iron. The ductile iron was equal in gall resistance to gray iron in which the flake-graphite content is lower than the nodular-graphite content. These results correspond to predictions from the mechanical analysis of seizing.

Porous chromium-plated surfaces are superior to the nonporous surfaces in resistance to galling. The effect of size, shape, and distribution of porosity again was found to be more critical than would be predicted from lubrication theory, since channel porosity of the chromium plate is superior to round-pit-type porosity.

For proper "wearing-in" of many metal parts, it is necessary to have good resistance to accelerated mechanical abrasion. Chemically pitted surfaces are known to be superior to "superfinished" surfaces in many such applications for wearing-in characteristics.

In most industrial applications the mechanical effect is complementary to the lubrication-film effect of separating the surfaces, but somewhat decreases the importance accorded to the lubrication effect alone. There is ample evidence that empirical methods have determined in many cases the importance of microscale engineered roughness, which is predicted (qualitatively, at this time) from the mechanical analysis of accelerated mechanical association. In future surface engineering such interpretations undoubtedly will be tested for quantitative validity.

Dynamic Properties of Nodular Cast Iron—Part II, Size Effect, by Harry Majors, Jr., Mem. ASME, Danville, Calif. 1953 ASME Semi-Annual Meeting paper No. 53—SA-25 (mimeographed; to be published in Trans. ASME).

ROTATING beam endurance tests at room temperature have been conducted on 0.86-in-diam minimum notch sections and 1.25-in-diam minimum unnotched sections in order to compare fatigue data obtained from geometrically similar specimens having minimum diameters of 0.19 in. and 0.30 in., respectively. Comparisons have been made for tension-test data obtained from sections of 0.19 in., 0.50 in., and 0.75 in. diam.

A series of exploratory tests in fatigue were made on grooved specimens and for two notch angles for comparison with results obtained on ungrooved specimens. Results are reported for the optimum chemical composition without any nickel content in the annealed and as-cast condition.

Petroleum

Comparison of Electric Motors and Steam Turbines as Drivers for Fluid Catalytic-Cracking Units, by H. C. Mayo, The M. W. Kellogg Company, New York, N. Y. 1953 ASME Semi-Annual Meeting paper No. 53—SA-60 (mimeographed).

A FLUID catalytic-cracking unit requires a large amount of power with a high degree of continuity. The initial investment and operating costs are materially influenced by the drivers employed.

This paper presents an analysis of the investment cost, operating cost, flexibility of operation, and operating record of steam-turbine and electric-motor drivers.

In order to give a realistic picture of the cost and economy involved, typical fluid catalytic-cracking units have been set up and investment and operating cost for electric and steam-turbine drivers in various locations determined.

It is concluded that plant investment costs can be substantially reduced by the use of electric-motor drivers in cases where the steam system is inadequate and where reliable power is available without too great a capital expenditure.

The operating cost for low-pressure condensing steam-turbine installations is higher in most areas than for electric motors supplied by purchased power.

The operating cost for high-pressure, high-temperature steam-turbine installations is lower in many areas than for electric motors. However, in areas where cheap hydroelectric power is available, the operating cost of motor drivers may be lower.

The maintenance costs of electric motors and the electrical system are lower than for turbines, condensers, and cooling towers.

Cooling-water requirements are reduced 30 to 50 per cent and space for cooling towers and steam generators is greatly reduced by the use of motor-driven compressors.

Well-designed electrical systems will provide the required service continuity.

Commercially available constant-speed centrifugal compressors have sufficient operating range for any application in a fluid catalytic-cracking unit.

The Entrainment Problem and a Simple, Economical Solution, by S. C. Reynolds, Metal Textile Corporation, Roselle, N. J. 1953 ASME Semi-Annual Meeting paper No. 53—SA-61 (mimeographed).

IN any processing operations involving the handling of liquids and gases in intimate contact, ultimate separation of these two phases is never complete, and varying amounts of liquid are always found entrained in the effluent gases. Since this is the result of physical or mechanical and not chemical reactions between the gas and the liquid, it is logical that industry should look to mechanical means for its control.

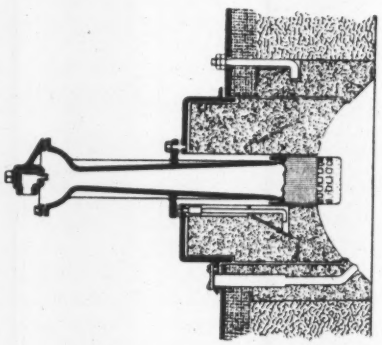
A solution to the entrainment problem is said to be the knitted wire-mesh entrainment separator, often called a mist eliminator. The unit, foraminous in structure, is made by assembling layers of knitted—not woven—wire mesh into a pad consisting of a multiplicity of unaligned, asymetrical openings. It removes the entrainment by impingement and accumulation in depth, as opposed to filtering by screens or sieves with minute and regular openings. Its structure contains sufficient wire surface area—approximately 125 sq ft per cu ft in the standard pad—to remove and collect practically 100 per cent of the entrained droplets under proper velocities and pressures. Also, the unit can be knitted and constructed of practically any metals or alloys (and many plastics) that are available in wire form, thus reducing the problem of corrosion to a minimum.

As the entrainment-laden gas passes through the knitted mesh unit, the liquid droplets impinge on the wires and are removed from the gas. Since the direction of flow is being continually changed as the gas swirls around to seek passage through the maze of wires, impingement of all the droplets is made easier and surer due to the inertia of the heavier liquid particles. As the impinged droplets build up on the wires, they coalesce and form large drops which flow down through the mesh and fall off into the rising vapor flow. The entrainment is literally wiped out and returned—the gas passes on, freed from the objectionable liquid.

Process Industries

A New-Type Radiant Tubular Heater, by T. F. Kreipe, Selas Corporation of America, Philadelphia, Pa. 1953 ASME Semi-Annual Meeting paper No. 53—SA-40 (mimeographed).

THE advantages of applying direct radiant heat to both sides of heating coils in tubular furnaces, as compared to the more customary direct application of radiant heat from one side only, is discussed. The operation, construction, and application of a novel radiant-type burner is described which embodies many de-



RADIANT-BURNER CROSS SECTION

sirable features. Use of the burner in tubular heaters is discussed and operating data is presented.

The new-type radiant burner deals with the problem of maintaining minimum excess air so that maximum radiant-heat transfer can be utilized. It also produces a very short flame with complete combustion. In the new-type burner, all of the air required for combustion is inspirated by an orifice in the gas supply feeding through a venturi throat to the burner tip. Additional mixing of the gas and air takes place in the burner ports and on the ceramic burner cup. There are no moving parts in the burner and the flame is confined within the burner cup. Proper sizing of the gas orifice assures that maximum excess air does not exceed 10 per cent and is usually between 0 and 5 per cent. No secondary air is required.

Production Engineering

Productionizing New Materials, by H. W. Benjamin, Lockheed Aircraft Corporation, Burbank, Calif. 1953 ASME Semi-Annual Meeting paper No. **53—SA-48** (mimeographed).

THE necessity to obtain basic fabrication data on a new material before releasing for design and production requires an orderly procedure for examination of the material by standard basic tests and the transmittal of experimental data to the affected engineering and manufacturing groups. A procedure for obtaining this information and the responsibility of various groups is discussed in this paper.

During the past 20 years the aircraft industry has been the focal point for many new metallic materials as well as new plastics, ceramics, adhesives, variations in glass, and many other combinations of materials.

The designer now realizes that the producibility and serviceability of a new material is equally as important as the initial weight saving and structural advantages claimed by the producer.

The management of the aircraft plants today realize that it costs money to put a new material into production and are willing, in general, to finance their share of a sound program to investigate thoroughly the structural and producibility aspects of the material.

A complete analysis of a new metallic material today includes the lab work necessary to prove out the producers' claims and furnish the additional information on properties required by the Structures and Methods Development groups. Design criteria on which to base a structural analysis is not enough for the designer as he must have complete design data on formability, weldability, and machineability in order to design for producibility. Forging, extruding, and casting properties must be considered and evaluated for producibility as well as structural advantages.

The nonmetallic, or loosely referred to as plastic, materials must also undergo a careful scrutiny by Structures and complete fabrication data obtained for the designer. In both types of materials, metallic and nonmetallic, the fabrication problem must be co-ordinated with manufacturing and the necessary process specifications and manufacturing standards compiled to assure a smooth flow of processing through the various shops.

When engineering and manufacturing have sufficient information to give a green light to the new material, the customer becomes another obstacle to overcome. Naturally, the customer is interested in serviceability, how this material stands up in all types of weather, landing conditions, and everyday servicing wear and tear. These questions can be answered partly in the laboratory, but nothing is more convincing than a sample part flying on the airplane in an easily accessible spot that can be readily inspected.

There are few in the aircraft industry that will disagree on the information needed to design for and manufacture with a new material, but few realize the amount of energy expended or the procedure required to develop orderly the producibility data required.

An outline of the basic tests required and a description of the type of data necessary for design and manufacturing helps to explain the cost, time span, and complications involved to productionize a new material.

An Engineering Approach to Methods Improvement and Planning, by L. C. Lander, Jr., Jun. ASME, General Motors Institute, Flint, Mich. 1953 ASME Semi-Annual Meeting paper No. **53—SA-67** (mimeographed).

THE search for better methods of performing activities in any field has been, and will continue to be, a worth-while objective for men in all fields of work. This applies particularly to activities within the engineering fields. Some of the improved methods found in other fields are basically engineering accomplishments attained through close cooperation of men of outstanding ability in the fields of endeavor involved. For example, the approach to solving several of the more complex problems, such as those resulting in the iron lung and the mechanical heart, was apparently one of first determining the human activity necessary to be carried on and then building a mechanism to improve the functioning of or to substitute for these human activities.

In methods engineering the approach to industrial-operation improvement is similar to the examples just given. The approach to finding improvements on industrial operations is first to determine the observable worker movements used by the workers in the performance of their work. Some of the observed worker movements are ineffective. Ineffective worker movements are the "indicators" of possibilities of operation improvement. The next step in gaining improved operations is to determine the "cause or causes" of the observed ineffective worker movements. The final step is to remove or minimize the cause or causes of ineffective worker movements. The removal of causes results in remedies. All remedies are devised and put into effect through the co-operative efforts of the technical men in the service departments, on the one hand, and the supervisors of the industrial operations involved, on the other hand.

Organization of Industrial Engineering in a Small Company, by A. M. Elliott, Lenkurt Electric Co., Inc., San Carlos, Calif. 1953 ASME Semi-Annual Meeting paper No. **53—SA-57** (mimeographed).

THE primary function of the Industrial Engineering Department at the Lenkurt Electric Company was to improve manufacturing methods to effect cost reduction. It was decided that each project would be set up by number and formally assigned to an engineer who has the entire responsibility for it. He is free to consult others but must make his own decisions. Investigation of a project by the Industrial Engineering Department may be requested by anyone through a department head.

Starting out on a project, the engineer first learns and records all he can about the present method: How many we make, how much it costs, what operations are performed and why. Having learned all he can about the present situation, he tries to improve it. If it is an assembly, are all parts essential? Can some be combined, modified, eliminated? Is it made on proper tooling—considering quantities used? He experiments, modi-

fies, consults, reviews, until he feels he has the best possible solution. This he discusses point by point with everyone concerned, engineers, foremen, supervisors, even line employees.

From these preliminaries often comes a new design requiring approval of the circuitry group. While this is being processed, the industrial engineering laboratory or other facility will be fabricating the necessary jigs, machinery, or equipment required.

Having achieved a new design, written up the new assembly procedure, and given a layout of the material consoles for the work positions, the industrial engineer will demonstrate the new method to the department foreman, supervisor, and operator, or to a training supervisor. He gives the foreman and production department the estimated standard output for the job.

While the foreman is responsible for maintaining standard, he is also equally responsible for trying to improve it. Unless improved, the industrial engineer's concepts must be rigidly adhered to.

Once the job is rolling, the industrial engineer watches it periodically, time-studying it at 30 days and again at 60 days, or as often as necessary. When he feels he has made all the major improvements he can and has satisfactorily answered the request of the person who initiated the project, he writes a report following a standard form under ten headings: Project, Subject, Requested by, Present Method, Action, Finding, Recommendations, Savings, Conclusion, Signature.

Aviation-Materials Handling

Modernization of the C-46 Airfreighter, by P. W. Miller, The Flying Tiger Line Inc., Burbank, Calif. 1953 ASME Semi-Annual Meeting paper No. **53—SA-83** (mimeographed).

THIS paper is a discussion of what has been done, is being done, and can be done with current C-46 flight equipment to combat obsolescence and therefore prolong its useful life.

The program of modernizing the C-46 airfreighter is one that has been in process for several years and is likely to remain in process throughout its economic life.

Superficially, the C-46 airfreighter in use by the air-cargo lines appears to be the standard Army Air Force C-46 with a new paint job. In actuality, the C-46 airfreighters originally put into commercial service were little more than this. The airplane itself was certificated under Civil Air Regulations Part 3, and few changes were required. Operational experience and new Civil Aeronautics Administration requirements have dictated a number of extensive modifications.

These modifications can be divided into three general subdivisions: (1) Instrumentation and radio-equipment modification; (2) Structural modification; (3) Power plant and power-plant installation modification.

The Aircraft Economic Parameter and Its Use in the Comparative Evaluation of All-Cargo-Type Aircraft, by G. A. Busch, Slick Airways, Inc., Burbank, Calif. 1953 ASME Semi-Annual Meeting paper No. **53—SA-84** (mimeographed).

THE selection of flight equipment is a matter of great importance to the airfreight carrier. Flight equipment represents the carrier's principal source of revenue. The direct cost of operating the flight equipment represents nearly two thirds of the carrier's operating expense. The investment in flight equipment is apt to account for half of the carrier's assets.

Since flight equipment falls in the category of capital goods, a decision, good or bad, to invest in a given type of flight equipment must be lived with for many years. An inept decision in this important matter can spell financial ruin. Therefore the carrier generally selects flight equipment on the basis of an exhaustive analysis in the context of his route structure of all potentialy suitable aircraft types.

In evaluating those types of aircraft which appear to be logical candidates for his fleet, the carrier sets up certain yardsticks against which he assesses the relative merits of each aircraft type. In the case of Slick Airways the following yardsticks were generally used: (1) Operating safely, (2) mechanical reliability, (3) competitive features (e.g., speed), (4) all-weather flight capabilities (e.g., high service ceiling), (5) cargo compartment space efficiency, and (6) the aircraft economic parameter.

This paper discusses the last of these yardsticks, the so-called aircraft economic parameter, and its method of use by Slick Airways.

The aircraft economic parameter may be defined as the ratio of the annual operating profit which an aircraft will generate to the initial cost of the aircraft. Put another way, the aircraft economic parameter is simply an expression of the classic "return on investment," a criterion historically used by prudent businessmen in nonsubsidized industry to evaluate proposed capital investments.

Power

Removal of Fireside Deposits Through Use of Mechanical Slag Blowers, by John A. Vanyo and S. F. Walleze, Continental Foundry & Machine Company, Erie, Pa. 1953 ASME Semi-Annual Meeting paper No. **53—SA-66** (mimeographed).

THE "slag problem" as presented by the firing of certain coals and oils, especially those of lower grades, has become a primary concern to utility personnel, boiler manufacturers, and boiler-accessory manufacturers. The basic problem has been present for many years, but it has increased in severity in certain sections of the country over the past 20 years.

This paper deals briefly with the cause, effect, and attempted solutions to the coal and oil-slagging problems, with emphasis on fireside deposits caused by oils as fired in the Florida and California areas. The question of the adequacy of mechanical slag blowers for the removal of these deposits is discussed, together with the merits of air versus steam as a cleaning medium, and recommendations for minimizing the extent of slagging problems.

It is pointed out that any information discussed is devoted to a majority of boilers included in this survey.

Specific examples will alter any information discussed in this paper.

Boiler-Cleaning Systems—Principles and Practices, by L. B. Schueler, Mem. ASME, Diamond Power Specialty Corporation, Lancaster, Ohio. 1953 ASME Semi-Annual Meeting paper No. **53—SA-24** (mimeographed).

FROM the commonly used term of "soot blower" we have come to a more comprehensive consideration of means for cleaning external surfaces of steam-generating units. From the relatively simple and basic problem of blowing lightly adherent "soot" or "fly ash" from boiler tube-bank surfaces to maintain cleanliness and absorption efficiency, we have come to face a problem of removing soot, fly-ash clinker, slag, and scale in various forms from generating, superheating, reheating, feed-heating, and air-heating surfaces in the form of tubular walls, tubular passages, and channel passages—with variations.

Today we are faced more and more with the problem of providing a "boiler-cleaning system," rather than an aggregate of soot-blower units. Boiler-clean-

ing systems have the manifold problem of contributing to safe, efficient, and reliable operation of a unit. We lay out cleaning systems: (1) to clean uniformly so that no abnormal conditions of heat absorption and consequent tube failure may occur; (2) to keep surfaces absorbing heat at highest efficiency and with least expenditure for blowing medium; and (3) to prevent formations of ash deposits which will cause or contribute to abnormal shutdown. Each of these functions, individually, is usually sufficient to warrant the system installation. The over-all benefits in all three categories are heavily in support of an adequate provision for a boiler-cleaning system.

This paper develops a general survey of the principles governing cleaning external surfaces of direct-fired heat-transfer surfaces and the equipment and operating methods involved. The discussion is confined principally to large-size steam-generating units fired by conventional fuels, primarily coal and oil.

Features of Nuclear Power Plant of Interest to Power-Plant Engineers and Operators, by R. A. Bowman, Mem. ASME, Bechtel Corporation Power Division, San Francisco, Calif. 1953 ASME Semi-Annual Meeting paper No. **53—SA-65** (mimeographed).

THIS paper attempts to predict the appearance from a power engineer's viewpoint of a nuclear power plant likely to be built in the near future and to give some idea of the operating procedures and requirements of such a plant.

The external appearance of a nuclear power plant will probably be very much like a conventional coal or oil-fired plant except that the boiler will be replaced by a building containing the reactor and steam generator. It will be a clean-looking plant with no coal or oil-storage facilities.

The reactor itself will be located in a square space at the center of the building, surrounded with concrete shielding about 10 ft thick. The auxiliary equipment such as pumps and heat exchangers will be shielded by concrete walls of a lesser thickness.

The plant will be divided into steam-producing and steam-using areas as is common with fuel-fired plants. The control room will be placed between these areas. The turbine may be located either indoors or outdoors but since concrete walls are required for shielding in the reactor area it is only natural that these walls will be utilized also as reactor building walls.

The provision of a stack in a nonfuel burning plant may appear superfluous at first glance but it serves as a convenient way of disposing of gases that might contain moderate amounts of radioactivity. Discharging gases well above the ground causes them to become diluted to safe tolerance before reaching inhabited areas. Ventilating air will normally be continuously discharged to this stack as a precautionary measure.

There is reason to expect that the basic flow diagram will resemble that of a conventional steam-power plant. The heat produced by nuclear fission in the reactor will be absorbed by the coolant circulating through the reactor and will then be transferred to boiling water to produce steam in the steam generator. The steam will then be used in a standard turbine heat cycle.

Design of Steam Piping and Valves for 1100 F, by F. A. Ritchings, Jun. ASME, and Sabin Crocker, Fellow ASME, Ebasco Services, Inc., New York, N. Y. 1953 ASME Semi-Annual Meeting paper No. **53—SA-37** (mimeographed; to be published in Trans. ASME).

RESULTS are available from extended research on the behavior of austenitic and ferritic steels in a steam atmosphere at 1100 F. Allowable stresses at temperatures up to 1100 F and higher have been assigned by code committees with respect to long-time strength as determined from creep and stress-to-rupture tests. Two large boiler-turbine units employing austenitic piping for 1100 F throttle steam temperature are being installed this year. Austenitic steels are definitely expensive, however, and alloying elements, particularly nickel and columbium, are in short supply.

This paper reviews existing data and speculates on whether low-alloy-content ferritic steels could be made to serve the purpose. Spot comparisons are made of the relative cost of austenitic and ferritic-steel pipe of equivalent carrying capacity.

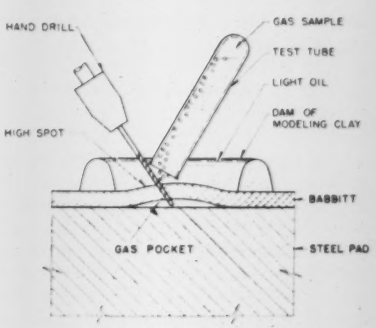
Austenitic steel (Type 347 18 per cent chromium, 8 per cent nickel plus columbium) was used for the 1100-F steam piping of two 145,000-kw units installed this year by the Public Service Electric and Gas Company of New Jersey in its Kearney Station. This is the first commercial installation for 1100 F steam. A report of the problems encountered and results obtained is awaited with interest. Experimental work there and elsewhere indicates that no serious difficulties should be encountered in using Type 347 material with 1100 F steam.

The question remains whether it is necessary and economic to use austenitic steels for 1100 F steam service. On the strength of information reviewed in the present paper, the authors conclude that it should be feasible to extend the use of low-alloy ferritic steels from their present top steam temperature of 1050 at turbine throttle to a possible 1100 F at turbine throttle. Before doing so on a wholesale scale, however, it is suggested that a trial installation be made in which the 1100 F steam piping consists in whole or in part of low-alloy ferritic steel. One of the items worth further investigation is the permanence at 1100 F of superior physical properties imparted to certain ferritic steels through favorable heat-treatment.

Prevention of Babbitt Blisters in Thrust-Bearing Pads, by R. A. Baudry, Mem. ASME, D. W. Gunther, and B. B. Winer, Westinghouse Electric Corporation, East Pittsburgh, Pa. 1953 ASME Semi-Annual Meeting paper No. **53—SA-23** (mimeographed; to be published in Trans. ASME).

BABBITT blisters were observed on water-wheel generator-bearing pads. Investigation revealed that these blisters resulted from the accumulation of high-pressure hydrogen at the steel-babbitt interface. The hydrogen, it was found, came from the steel and was introduced during the manufacture of the steel. The maximum level of hydrogen content to insure freedom from blisters was determined. Processes to remove hydrogen from the steel were developed.

Investigation and operating experience indicated that such hydrogen-produced babbitt blisters were an important factor affecting the performance of thrust bearings. In the past, such blisters occasionally had been observed on thrust pads that had been held in storage for several years. However, it had never been appreciated that these blisters could result in the failure of thrust bearings. It is now apparent that such failures have occurred in the past, but were never explained because the wiping of the bab-



METHOD OF COLLECTING HYDROGEN FROM BABBITT BLISTER IN THRUST-BEARING SHOE

bitting had obscured the cause of the trouble.

As part of the investigation which followed the discovery of blisters, laboratory tests were conducted on steel specimens covered with babbitt. In order to accelerate the process, these specimens were kept at a temperature of 150 C for a period of time. It was found that blisters were formed rapidly.

It was first thought that the hydrogen causing the babbit blistering resulted from the pickling or fluxing of the pads during the babbitting process. Refinements of the process to eliminate pickling and insure the complete removal of flux resulted in improvements, but did not prevent the formation of blisters.

It was then suggested that the hydrogen causing the blisters could be contained in solution in the steel. This was confirmed by a survey of the literature and additional blistering tests on small samples.

It is concluded that hydrogen contained in commercial steels is responsible for the babbitt blisters observed in bearings. A low level of hydrogen content is required to prevent the formation of blisters. This low level is obtained and insured by suitable heat-treatment and quality control.

As a result of this investigation the quality of the babbitt bond also has been improved. The improved manufacturing process combined with modern inspection techniques results in thrust-bearing pads of high quality and increases the reliability of large water-wheel generators.

Effect of Exhaust Pressure on the Economy of Condensing Turbines, by A. Keller, Mem. ASME, General Electric Company, Lynn, Mass., and J. E. Downs, Mem. ASME, General Electric Company, Schenectady, N. Y. 1953 ASME Semi-Annual Meeting paper No. **53—SA-73** (mimeographed).

THIS paper attempts to provide quick and accurate methods of determining the change in heat rate, nonextraction steam rate, or turbine capability resulting from changes in the exhaust pressure of condensing turbines. The methods are applicable for turbines from 25,000 kw to the maximum size built by the authors' company.

It is believed that these data will be useful to the power-station designer in selecting between alternate turbine designs with different last-stage bucket annulus areas available in the larger ratings, and also helpful in the selection of condenser size. It will also be useful to the operating engineer in determining when condenser maintenance is advisable; for correcting test data to base exhaust pressure for comparison with guarantee or expected information, and showing the desirability of operation with less than maximum condenser circulating-water-pump capacity in cold weather.

The authors believe that the method for obtaining exhaust-pressure corrections outlined in this paper will prove useful to users of steam turbines. The method, which is confirmed by test data, can be easily applied when only a few parameters for the specific turbine for which corrections are desired are known.

Fabrication of Austenitic Stainless-Steel Steam Piping for Operation at 1100 F, by W. G. Benz and R. H. Caughey, The M. W. Kellogg Company, Jersey City, N. J. 1953 ASME Semi-Annual Meeting paper No. **53—SA-58** (mimeographed).

THIS paper, in the first of two parts, presents the results of a metallurgical investigation leading to the recommendation of welding and heat-treating procedures for austenitic type 347 (18 Cr-10 Ni-Cb) stainless-steel steam piping for operation at 1100 F. In the second part the steps in the shop fabrication of piping assemblies of this material are described in detail.

According to the paper, ferrite-bearing-type 347 weld deposits should continue to be the practice in welding-type 347 piping systems for use in electric generating stations. Continued studies toward the development of a satisfactory fully austenitic deposit are recommended.

Electrode composition should be balanced to produce deposits containing from 1 to 4 per cent ferrite.

Levels of certain elements in the deposit should be held within the following limitations. (*a*) carbon—0.07 to 0.10 per cent; (*b*) silicon—5× per cent C (approximate); (*c*) columbium—0.60 to 0.90 per cent.

A postwelding solution heat-treatment at 1950 F is recommended for type 347 piping operating at elevated temperatures. The recommended heat cycle for this treatment is: (*a*) Heat rapidly to 600 F; (*b*) 600 F to 1100 F heat at a rate not to exceed 300 F per hr maximum; (*c*) hold for 2 hours at 1000 F to 1100 F; (*d*) continue heating from 1000 F to 1950 F a minimum rate of 600 F per hr; (*e*) hold at 1950 F for 2 hr; (*f*) air cool from 1950 F as rapidly and as uniformly as possible.

After the results of the metallurgical investigation were reviewed, the shop procedure for fabricating stainless-steel power piping was modified to specify the special low-ferrite-type 347 electrode with a postwelding solution heat-treatment at 1900 F. In addition, since K-welding had been used successfully to make the test joints for the investigation, The M. W. Kellogg Company was requested to fabricate both main steam and turbine lead assemblies with this process because high-quality, complete penetration welds having a controlled inside contour can be made without the use of backing rings. This application of inert-gas-shielded arc welding combined with a pressure-controlled inert-gas backup is described and the steps involved in the fabrication of these type 347 steel piping assemblies are briefly discussed.

Applied Mechanics

The Torsion of Spiral Rods, by H. Okubo, Tohoku University, Sendai, Japan. 1953 ASME Applied Mechanics Division Conference paper No. **53—APM-2** (in type; to be published in the *Journal of Applied Mechanics*).

THE torsion and stretching problems of spiral rods were treated in earlier papers. The present paper is a continuation of the previous studies. In the previous calculations, the equations of equilibrium expressed in terms of displacements were used.

The equations of equilibrium with those of compatibility are derived in two-dimensional forms for the present problem. They are simplified in two extreme cases where (1) The angle between the helix and the axis of helix is small, and (2) The angle between the helix and the plane perpendicular to the axis of helix is small. Using them, expressions for stresses are derived in the forms, which contain two arbitrary functions satisfying the Laplace or a similar equation, and the Airy equation, respectively.

As an illustration of the procedure, a detailed solution for a coiled helical spring with a circular section is obtained by means of successive approximations.

Some New Types of Orthotropic Plates Laminated of Orthotropic Material, by C. Bassel Smith, University of Florida, Gainesville, Fla. 1953 ASME Applied Mechanics Division Conference paper No. **53—APM-6** (in type; to be published in the *Journal of Applied Mechanics*).

PLYWOOD plates are usually constructed so that the grain of adjacent plies is perpendicular. Such laminated plates possess two perpendicular axes of elastic symmetry. In this discussion plywood plates having other than 90-

degree angles between the grain of adjacent plies are considered.

First, a two-ply plate with the grain of one ply making any arbitrary angle with the grain of the other ply is discussed. It is shown that this plate, when in a state of plane stress or when subjected to small deflections, possesses the same two perpendicular axes of elastic symmetry.

By making use of the formulas obtained for the two-ply plate, it is shown how to construct a plate of any number of plies (the adjacent plies not necessarily having their grain perpendicular) possessing the same type of elastic symmetry as the two-ply plate.

Reinforced Circular Holes in Bending With Shear, by S. R. Heller, Jr., Bureau of Ships, Navy Department, Washington, D. C. 1953 ASME Applied Mechanics Division Conference paper No. **53—APM-9** (in type; to be published in the *Journal of Applied Mechanics*).

THE object of this paper is the determination of the effect of the reinforcement of circular holes on the stress distribution in the webs of beams subjected to bending with shear. A theoretical solution for a bead-type reinforcement, i.e., small radial thickness, is developed.

The stress distribution in the web for arbitrary shape reinforcement is based on the work of Reissner and Morduchow. The theory developed is valid provided the diameter of the hole does not exceed one fourth of the depth of the beam.

Axisymmetric Flexural Temperature Stresses in Circular Plates, by J. E. Goldberg, Purdue University, Lafayette, Ind. 1953 ASME Applied Mechanics Division Conference paper No. **53—APM-5** (in type; to be published in *Journal of Applied Mechanics*).

THE problem considered in this paper is that of determining the flexural stresses which result from temperature differences T between corresponding points on the upper and lower faces of circular plates (T = temperature at lower face minus temperature at upper face), when T is assumed to vary only with the distance from the center of the plate.

This problem arises, for example, in the design of heated or cooled cylindrical processing tanks or vessels. In such cases, heat may be applied to the circular bottom of the vessel by a single concentric burner or heating element or by a ring of burners or elements. The resulting temperature distribution will be approximately axisymmetric.

This analysis applies specifically to the special case of a circular plate in which the temperatures (a) vary linearly between corresponding points on the upper and lower surfaces, (b) are zero at any instant over the entire median surface, and (c) vary only slowly with time.

An Improved Electrical Analogy for the Analysis of Beams in Bending, by W. T. Russell, U. S. Army, Fort Sill, Okla., and R. H. MacNeal, California Institute of Technology, Pasadena, Calif. 1953 ASME Applied Mechanics Division Conference paper No. **53—APM-11** (in type; to be published in the *Journal of Applied Mechanics*).

IN the past decade several electrical analogies have been devised which can be used in the solution of problems concerning the bending of elastic beams. Some of these can be used only in the solution of problems with static loads, while others, in addition, can be used in normal mode analyses. Still others can be used in the solution of transient problems. The usefulness of these circuits is not restricted to elementary beam problems because they can serve as building blocks in the construction of analogous circuits for such complicated structures as airplanes, ships' hulls, and gas turbines. In this paper a new analogy is presented and its advantages over others previously published are pointed out.

A practical electrical-beam analogy which employs ideal transformers is derived from the equations of a segment of nonuniform beam which is loaded by vertical shears and moments applied at its ends. This analogy is suitable for the solution of static-load problems, vibrations problems, and transient-load problems.

The superiority of this analogy over an analogy derived by replacing differential operators by difference operators is demonstrated by means of error calculations for uniform cantilever and simply supported beams.

Solutions of Heat-Conduction Problem With the Aid of the Inverse Method, by F. S. Weinig, General Electric Company, Cincinnati, Ohio. 1953 ASME Applied Mechanics Division Conference paper No. **53—APM-25** (in type; to be published in the *Journal of Applied Mechanics*).

USING a known solution of the potential equation for heat conduction it is possible to determine boundaries which fulfill the boundary conditions. This idea was applied to the heat flow with parallel streamlines, from a line source and from a point source. From the parallel flow, fins have been derived on a plane surface having circular arc flanks. From the line source, fins axially and radially on a cylindrical surface, and from a point source, fins on a sphere are obtained.

The improvement of the heat transfer has been found in these examples to depend only on the surface direction at the base of the fins.

Transient Thermal Stresses in Slabs and Circular Pressure Vessels, by M. P. Heisler, North American Aviation, Inc., Downey, Calif. 1953 ASME Applied Mechanics Division Conference paper No. **53—APM-8** (in type; to be published in the *Journal of Applied Mechanics*).

THIS paper presents the results of computations for determining transient thermal stresses in slabs and circular pressure vessels. The process of solution adopted is to substitute transient-temperature formulas into the already available stress expressions. The expressions for thermal shock are transformed by means of a simple integral theorem into a form appropriate for analyzing the thermal processes commonly used to relieve thermal shock.

A new dimensionless stress parameter is defined and applied to the determination of optimum heating or cooling times of massive pressure vessels.

Determination of Stresses in Cemented Lap Joints, by R. W. Cornell, Jun. ASME, United Aircraft Corporation, Windsor Locks, Conn. 1953 ASME Applied Mechanics Division Conference paper No. **53—APM-15** (in type; to be published in the *Journal of Applied Mechanics*).

A VARIATION and extension of Goland and Reissner's method of approach is presented for determining the stresses in cemented lap joints by assuming that the two lap-joint plates act like simple beams and the more elastic cement layer is an infinite number of shear and tension springs.

Differential equations are set up which describe the transfer of the load in one beam through the springs to the other beam. From the solution of these differential equations a fairly complete analysis of the stresses in the lap joint is obtained.

The spring-beam analogy method is applied to a particular type of lap joint, and an analysis of the stresses at the discontinuity, stress distributions, and the effects of variables on these stresses are presented. In order to check the analytical results, they are compared to photoelastic and brittle-lacquer experimental results.

The spring-beam analogy solution was found to give a fairly accurate presentation of the stresses in the lap joint investigated and should be useful in analyzing other cemented lap-joint structures.

Effect of Range of Stress on Fatigue of 76S-T61 Aluminum Alloy Under Combined Stresses Which Produce Yielding, by W. N. Findley, University of Illinois, Urbana, Ill. 1953 ASME Applied Mechanics Division Conference paper No. **53—APM-12** (in type; to be published in the *Journal of Applied Mechanics*).

IN another paper the results of fatigue tests of 76S-T61 aluminum alloy under combined bending and torsion were presented and compared with various theories of failure. In the present paper these data have been extended to include the additional variable of "range-of-stress" and its effect under different combinations of bending and torsion. The term range-of-stress is used here in the broadest sense, as employed by Smith, for example, to describe in a general way a relationship between the maximum and minimum stress in a cycle of stress.

A complete description of a sinusoidal cycle of stress requires two algebraic quantities, such as maximum and minimum stress, alternating stress amplitude and mean stress, range ratio and maximum stress, alternating stress amplitude and maximum stress, alternating stress amplitude and minimum stress, and so on.

Fatigue test data under bending, torsion, and combined bending and torsion are presented for mean stresses from zero to values which cause substantial yielding. The mean normal stresses in the bending and the torsion tests were corrected for the effect of the nonlinear distribution of stress resulting from yielding. Static tests in tension, compression, bending, and torsion also are described.

Calculation of Elastic Displacements From Photoelastic Curves, by H. Poritsky, Mem. ASME, and R. P. Jerrard, General Electric Company, Schenectady, N. Y. 1953 ASME Applied Mechanics Division Conference paper No. **53—APM-16** (in type; to be published in the *Journal of Applied Mechanics*).

A METHOD of utilizing photoelastic fringe patterns for purposes of calculating elastic displacements of stressed members is developed. This method utilizes only the lines of constant principal stress difference and does not require knowledge of the directions of the principal stresses.

The method developed should prove useful in many cases where measurements of elastic displacements cannot be carried out conveniently but photoelastic fringe patterns are readily available. As an example, the two-dimensional case of a beam in bending with a change in thickness is treated. The correction that must be applied to simple beam theory is determined.

High-Temperature Compression Testing of Graphite, by Leon Green, Jr., Jun. ASME, Aerojet Engineering Corporation, Azuza, Calif. 1953 ASME Applied Mechanics Division Conference paper No. **53—APM-4** (in type; to be published in the *Journal of Applied Mechanics*).

EXPERIMENTS on the compression of graphite cylinders at elevated temperatures are described. It is found that the short-time compressive strength increases with temperature in the range from room temperature to 2000 C, a variation which is consistent with the previously reported behavior of the tensile strength. Photographs of typical modes of deformation and their corresponding stress-strain curves are presented. However, a limited degree of temperature control renders the curves semiquantitative in nature. The large, mutually opposing influences of temperature and strain rate are illustrated by photographs of typical failures. Stress-relaxation curves manifest the plasticity of graphite at high temperatures.

From the results of the exploratory experiments described in this paper, it is concluded that the mechanical properties of graphite and their thermal dependence deserve further study with equipment of increased precision and flexibility. It is suggested that experiments conducted under large hydrostatic pressures might prove highly informative, although the experimental difficulties involved by such tests at high temperatures (which would require the use of an inert gas) might prove formidable. There is good reason to expect that in such experiments graphite may exhibit increasingly ductile behavior as the pressure level is raised, in a fashion possibly analogous to the behavior exhibited by marble in the classical experiments by von Kármán.

Finally, the possibility of increasing the density of unavoidably porous commerical graphite by compressing it at a temperature high enough and at a rate slow enough to insure that all the deformation occurs by a diffusion mechanism without any local fracturing appears especially attractive. This is because completely bonded graphite of maximum theoretical density (2.25 grams per cu cm) almost certainly would exhibit greatly improved strength properties.

ASME Transactions for September, 1953

THE September, 1953, issue of the Transactions of the ASME, which is the *Journal of Applied Mechanics* (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following:

TECHNICAL PAPERS

Singular Yield Conditions and Associated Flow Rules, by William Prager. (53—APM-23)

Graphical-Numerical Solution of Problems of Saint-Venant Torsion and Bending, by B. A. Boley. (53—APM-22)

Elastic Spheres in Contact Under Varying Oblique Forces, by R. D. Mindlin and H. Deresiewicz. (53—APM-14)

Combined Bending and Twisting of Thin Tubes in the Plastic Range, by E. T. Onat and R. T. Shield. (53—APM-18)

Improved Electrical Analogy for Analysis of Beams in Bending, by W. T. Russell and R. H. MacNeal. (53—APM-11)

Determination of Stresses in Cemented Lap Joints, by R. W. Cornell. (53—APM-15)

Effect of Range of Stress on Fatigue of 76S-T61 Aluminum Alloy, by W. N. Findley. (53—APM-12)

Calculation of Elastic Displacements From Photoelastic Curves, by H. Poritsky and R. P. Jerrard. (53—APM-16)

The Vibration of Rotating, Tapered-Twisted Beams, by G. W. Jarrett and P. C. Warner. (53—APM-17)

Two-Dimensional Diffuser Flow, by K. R. Galle and R. C. Binder. (53—APM-20)

Axisymmetric Flow of Ideal Incompressible Fluid About a Solid Torus, by E. Sternberg and M. A. Sadowsky. (53—APM-7)

Viscous Flow Through Axial Turbomachines, by T. P. Torda, H. H. Hilton, and F. C. Hall. (53—APM-28)

Temperature Distribution in the Wake of a Heated Sphere, by D. H. Baer, W. G. Schlinger, V. J. Berry, and B. H. Sage. (53—SA-2)

Laminar Boundary-Layer Flow With Variable Properties, by S. Levy and R. A. Seban (53—SA-3)

Measurement of Acceleration Pulses, by Henry Shapiro and D. E. Hudson. (53—SA-8)

Transient Deformations in Elastoplastic Media, by E. J. Sternglass and D. A. Stuart.

DESIGN DATA AND METHODS

Design of Helical and Leaf Springs for Minimum Weight, by M. F. Spotts

DISCUSSION

On Previously Published Papers by H. H. Bleich; E. H. Kennard; A. K. Oppenheim; D. S. Carter; W. R. Sears; Samuel Levy; W. Wright; T. P. Torda, W. O. Ackermann, and H. R. Burnett; S. I. Pai; and H. D. Conway.

BRIEF NOTES

A Strain-Energy Expression for Thin Cylindrical Shells, by H. H. Bleich and F. Dimaggio.

Angle and Strain Relations in Flat-Plate Lüders' Bands, by G. R. Irwin.

Note on Oil Whip, by Oscar Pinkus.

BOOK REVIEWS

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Dynamic Behavior of Linear Production Systems

COMMENT BY RUFUS OLDENBURGER[1]

In this paper[2] certain mathematical theory, so successfully used in the practical design of automatic controls, is applied to production systems in which human beings play a role. The writer is reminded of a course in mathematical economics which he once attended, only to find that it was merely advanced calculus with new terms. Thus a "contour line" of advanced calculus became a "line of indifference." Part of advanced calculus had been taken over bodily to give a quantitative picture of a field, where a vast number of unknown factors made it impossible to use the theory to make money.

The writer has spent most of his working life as a professor of mathematics, engaged in teaching and research in pure mathematics. Therefore, speaking for mathematicians as a whole, it may be said that mathematicians generally had serious misgivings when Bertrand Russell forsook pure mathematics for marriage and morals, and Prof. Norbert Wiener began devoting his time to economic, social, and other areas of activity. Professor Wiener is in many respects the best mathematician this country has produced. The writer feels strongly that society is fortunate when such men leave their ivory towers to apply their mathematical viewpoints to other fields of endeavor, even though these applications appear not to be of the kind that will bring immediate practical results to the benefit of man. These thinkers can give us vision we otherwise would not have, and they can show us the way we should go. Although the unknown quantities in the author's theory make its application difficult, and such applications appear to be far in the future, there is nevertheless a chance that the approach of his paper may have immediate use if the right problem presents itself. In any case, this type of paper helps us to understand ourselves and the world around us.

The author assumes that he can treat his problem as a linear one. It is our experience that this is often justified in qualitative studies. We always have found, even in quantitative analyses where great accuracy was not required, that the assumption of linearity gave good agreement between experimental and theoretical results.

The inclusion of transportation lag, through the operator e^{-as}, in the author's list of mathematical operators is fortunate. At the writer's company, we have found this lag to be important even where there is no transportation involved. When we could not explain the discrepancy between theory and experiment in the case of a gas-turbine speed governor, we made frequency-response runs on the turbine and found a dead time of $^1/_{15}$ sec which explained the disagreement. At the NACA Lewis Laboratory they subsequently found that this dead time could be as much as $^1/_4$ sec and resulted from the time it takes to form one combustion pattern from another. The rest of the author's list can be included in the expressions

$$P(s), \quad \frac{es + f}{gs^2 + hs + k} \qquad [1]$$

where the letters other than s indicate constants, some of which may vanish, and $P(s)$ is a polynomial in s. These expressions cover more transfer functions than those in the author's list. The Swedish firm ASEA made frequency-response runs on the entire Swedish network to obtain the transfer function relating power to system frequency. In their more accurate study of the network they obtained a transfer function of the form of the fraction in Expressions [1] with the constants all different from zero, and where this fraction cannot be simplified further, and thus cannot be reduced to the functions in the author's list.

In linear theory one normally would expect to obtain a rational function of s as the transfer function, that is, the quotient of two polynomials in s. Nature is kind in that the real factors of the denominator are generally distinct. The given rational function can be split up in the real field of numbers into a sum of partial fractions and a polynomial, where these are as given in Expressions [1]. Since derivatives appear to be associated only with lags, accurate representations would not involve $P(s)$, but only the fractions.

[1] Mathematician Engineer, Woodward Governor Company, Rockford, Ill. Mem. ASME.

[2] "Dynamic Behavior of Linear Production Systems," by D. P. Campbell, MECHANICAL ENGINEERING, vol. 75, April, 1953, pp. 279–283.

Cutting Characteristics of Titanium

COMMENT BY O. W. BOSTON[3]

The authors are to be commended for the clarity of their presentation of the material relating to the cutting characteristics of titanium,[4] and for showing the manner in which titanium differs from several other metals. This paper represents results from one portion of a research program sponsored by the Army Ordnance through the Detroit Ordnance District at the Engineering Research Institute of the University of Michigan. The work was done in the laboratories of the Department of Production Engineering. The writer is supervisor of this program and Professor Colwell is assistant supervisor. A number of additional papers on the machining of titanium are contemplated giving further results as they mature.

This paper reveals certain conclusions as to the principles involved in forming titanium into chips which are different from those for other metals. Probably the outstanding significance of the paper is the definite proof of the small amount of work-hardening in titanium as it is deformed as compared with other metals, particularly stainless steel. Most of the literature written on the machining of titanium states that it machines like stainless steel. This paper shows clearly that this statement is not true. Each of the three types (analyses) of titanium

[3] Chairman, Department of Mechanical and Production Engineering, College of Engineering, University of Michigan, Ann Arbor, Mich. Fellow ASME.

[4] "Cutting Characteristics of Titanium and Its Alloys," by L. V. Colwell and W. C. Truckenmiller, MECHANICAL ENGINEERING, vol. 75, June, 1953, pp. 461–466, 480.

covered in the experiments has its individual characteristics, but the main characteristic seems to be that of the small amount of distortion in the shear area. Most of the mathematical analyses of the metal-cuttting process, as given during the past several years, have been based on the shear plane. The writer has felt continuously that this is a misnomer and that the term should be the "area of shear." The photomicrographs show clearly that there is a great deal of metal deformation ahead of the cutting edge both in the formation of the chip and the separation of the chip from the parent metal.

It is hoped that this information will be of help to those who are interested in making analytical studies of the forces and plastic flow so that the results of such computations may be used more positively in predetermining machinability when physical and metallurgical properties are known.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Nuclear Physics

EXPERIMENTAL NUCLEAR PHYSICS. Vol. 1 E. Segrè, editor. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Ltd., London, England, 1953. Cloth, 5½ × 9 in., tables, figs., references, author and subject indexes, ix and 789 pp., $15.

REVIEWED BY C. S. WU[1]

THE rapid progress made in the various branches of nuclear science has attained such stupendous magnitude and refinement that no single person could attempt to write an authoritative account of them all. Yet, eager and ambitious young students and research workers in the field of nuclear science or its allied subjects have often wished that there were such a book, from which they could find out the present status of nuclear science, the up-to-date methods of investigation, and the appropriate formulas and theories for interpreting the data and facts. The series of three volumes entitled "Experimental Nuclear Physics," edited by Prof. Emilio Segrè, was planned to fulfill such a demand. The first volume comprises the concerted efforts of five men, outstanding authorities in their respective fields.

Part 1, on "Detection Methods," is contributed by Hans H. Staub, who is coauthor with Rossi of the excellent book, "Ionization Chambers and Counters." A great portion of Part 1 is devoted to the fundamental behavior of ionization. The detailed analysis of the motion of ions and electrons in gases is the outstanding feature of this section. The general properties of various detectors based on ionization processes are also presented and the discussions on the shape of the pulses from different detectors are most illuminating and helpful. The author has also done an excellent job in describing the most currently used forms of electronic instruments. He has stated their functions, limitations, modifications, and the latest designs, and left the detailed analysis of the circuits to specific references. The detailed description of constructions and methods at the end of this part should prove helpful to all those who have to design their own detectors. Unfortunately, however, the scintillation counter, Cerenkov counter, and photographic plate method would have occupied a more prominent place had the closing date of the material been extended to the beginning of 1952, as in the sections of the other authors.

Part 2, entitled "Passage of Radiations Through Matter," has been written by Hans A. Bethe and Julius Ashkin, whose original contributions to this important field are well known. In presenting this subject, they have divided the material into three sections, dealing separately with heavy particles, beta-rays, and gamma-rays.

In the first section, the authors have begun by outlining the theoretical background and method of approach and then presented the results. An immeasurable help to the research workers who must use stopping power formulas is the lengthy discussion on the stopping number, B, and the average excitation potential, I. Large numbers of figures illustrating the "energy and range" and "energy and stopping power" relations of protons and alpha-particles in various substances will prove very convenient as general references.

The second section is on the penetration of beta-rays through matter. Because of the scattering and straggling effects which are particularly pronounced in the penetration of beta-rays, no comparison could be made between the energy-range relation derived from the energy-loss consideration and the experimental results. However, the subject of radiative collisions of electrons was treated in great detail. Also found in this section is an excellent discussion on multiple scattering and energy determination through absorption methods.

The third section contains all essential formulas and curves for photoelectric, Compton scattering, pair production, and total absorption cross sections in different energy ranges. Their origins and references are given, the limitations in application are cautioned, and their comparisons with experimental results are discussed. All in all, Part 2 is essential reading for those experimental research workers who hope to interpret their measurements intelligently.

Part 3, entitled "Nuclear Moments and Statistics," is a review and summary ably written by Norman F. Ramsey. The rapid developments in this field are extremely diversified, and yet no reviewing article has been previously written on it in any English language journal. It is indeed gratifying to have, at last, an article on this subject written with such unusually high standards.

The first section serves as an introduction; the second reviews the various interactions that a nucleus makes with atomic and molecular fields; and the third describes in detail the various experimental methods of measuring nuclear moments and statistics. The last section deals with the interpretation of the results and brings to light the significance of some nuclear moment results. The author's thorough familiarity with the theoretical as well as the experimental aspect of the field make this review profitable as well as interesting reading.

[1] Associate Professor of Physics, Pupin Hall, Columbia University, New York, N. Y.

Part 4 on "Nuclear Two-Body Problems and Elements of Nuclear Structure" is also contributed by Norman F. Ramsey. There has probably been far more theoretical and experimental work done on this subject than on any other subject in nuclear physics. Ramsey has presented his material here in an orderly fashion and organized the experimental results and the theoretical analysis in a logical manner. He gives to his readers a clear picture of the importance of the subject, the methods of approach, procedures for the analysis of data and facts, and the present status and future possibilities of this field.

Part 5 on isotopic abundances, atomic masses, and mass spectroscopy, is contributed by K. T. Bainbridge. This is a fully developed field. The technique and methods employed are refined and precise. The author's intimate knowledge and experience in this field enable him to give an authoritative account of the theoretical significance, the experimental procedure, and methods of analysis of this highly specialized art. Numerous tables are included in this section, containing such information as the relative isotopic abundances, nuclear reaction Q values and isotopic weights, which must have consumed long hours of preparation and they are certainly invaluable help to the reader.

W. F. Durand

ADVENTURES—In the Navy, in Education, Science, Engineering, and in War. By W. F. Durand, Past-President and Hon. Mem. ASME. The American Society of Mechanical Engineers and McGraw-Hill Book Company, New York, N. Y., 1953. Cloth, $5^1/_4 \times 8^1/_2$ in., 212 + xii pp., with index and bibliography of published work, $4.

REVIEWED BY J. C. HUNSAKER[2]

THIS is the life story of the dean of American mechanical engineers recording the incidents of a life-span of some 94 years, as Dr. Durand might recall them of a summer evening sitting on his wooden bench beneath the great live oak tree at Stanford University. Nothing is said of personal ambitions, or controversy, nor is there a hint of disappointment with the motives or actions of other people. The events of long and distinguished service to his country and to his profession receive brief mention, and this mention contains more of humility and wonder that unexpected opportunities came to him than of satisfaction with repeated success.

A reader will be puzzled to discover the means by which Dr. Durand's outstanding leadership in the engineering profession was achieved. Still more will such a reader be puzzled to discover why so modest and simple a man was in such demand as a consultant on so many of the great engineering projects of this century.

While on the Stanford faculty, and especially after his retirement in 1924, Dr. Durand was much sought after for advice in his individual professional capacity. He had no technical staff, no partners nor business associates, yet he was for many years consultant at the highest level for the great hydraulic works of the West; including the Hoover dam, the Grand Coulee dam, and the Shasta and Friant dams on the Sacramento and San Joaquin Rivers in California. He advised the City of San Francisco in the planning and construction of the Hetch Hetchy water supply and power project, and Los Angeles County in connection with the pumping equipment for the great Colorado River Canal to bring river water to the thirsty cities of southern California. For 30 years he served as consultant to the City of Los Angeles in the progressive development of her great Owens Valley water and electrical supply systems.

It can be concluded from the autobiography that Dr. Durand's professional advice must have been wanted not only because it was based on the broadest consideration of the engineering and economic problem, but also because he gave discreet consideration to the social problems involved in what could be politically explosive situations.

Dr. Durand refers to his report on the feasibility and desirability of what later became the Hoover dam as having "had some influence favoring the legislation which finally led to the construction of the dam and the installation of the hydroelectric generating equipment."

Secretary Ickes in 1936 appointed Dr. Durand and two others to evaluate the controversial Passamaquoddy Tidal Power Project. This must have been an unhappy assignment, but Dr. Durand voices no criticism of the promoters of this "make-work" scheme, and sums up the matter in his characteristically temperate manner: "In substance our report found the project possible as an engineering undertaking, but, under existing conditions at that time, uneconomic as a source of power in comparison with other sources, and hence indefensible from an economic and broad viewpoint. Apparently our report furnished a means of quietly burying the proposal for the time being. It may reappear."

Hugh L. Dryden's preface mentions Dr. Durand's three careers: first, as a marine engineer and naval officer; secondly, in teaching and research; and thirdly, in aeronautics. I think there is also disclosed a fourth career as an engineering statesman, working with others to achieve broad objectives. Dr. Durand has been famous for bringing about agreement between conflicting ambitions and interests. The account of some of his more important public services gives no more than a suggestion of an explanation of this facility. Leadership is, no doubt, a thing of the spirit based on character combined with high professional competence. It is not so much assumed as it is accorded as a matter of trust.

In the autobiography it is clear that we are reading the thoughts of a gentle, modest man, without a trace of malice or selfish ambition. Perhaps this is the key to Dr. Durand's extraordinary success as first Chairman of the National Advisory Committee for Aeronautics and of its special Committee on Jet Propulsion, as President of The American Society of Mechanical Engineers, on the Morrow Air Board, Trustee of the Daniel Guggenheim Fund and editor of its encyclopedic volumes on Aerodynamic Theory, Chairman of the 1936 World Power Conference, National President of the Society of the Sigma Xi, and Chairman of the Engineering Division of the National Research Council during World War II.

Dr. Durand tells of his appointment in 1925 by President Coolidge to a Board of Aeronautic Inquiry, organized with Dwight Morrow as chairman and Dr. Durand as secretary. This Morrow Board was created largely because of the controversy regarding military and naval aviation precipitated by the late Brigadier General William Mitchell of the Army Air Corps. Dr. Durand records with satisfaction that the recommendations of this Board resulted in a good plan of aviation development and the establishment of Assistant Secretaries for Air in the War and Navy Departments. He makes no mention of Billy Mitchell and his bitter charges which the Board had to deal with for many weary weeks. This is characteristic of Dr. Durand's patient and detached view of burning issues which cool off as time works toward their resolution.

Then follows an account of his teaching career at Worcester Polytechnic, Michigan State, Cornell, and finally at Stanford University.

[2] Professor Emeritus of Aeronautical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. Hon. Mem. ASME.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

Dr. Durand was three times uprooted from his pleasant home in California by what he felt to be the call of duty. In the first world war, he took leave from his university to accept President Woodrow Wilson's appointment to the newly created National Advisory Committee for Aeronautics in Washington. A year later he moved to Paris, France, to serve as Scientific Attaché to the U. S. Embassy for the duration of the war. There he experienced both aerial bombardment and the fire of the German long-range guns. The second uprooting came with his election as President of ASME in 1924. He moved to New York for a year, but traveled extensively to visit the local sections of the Society. The third uprooting came in 1941 when, at the age of 83, he was called to Washington by Dr. Vannevar Bush, chairman of NACA, to take charge of the development of jet-propulsion engines for our aircraft program. Having arrived in Washington, he was at once drafted by the National Academy of Sciences as Director of the Engineering Division of the National Research Council. He consequently supervised two major programs, each a full-time job for a much younger man.

In his autobiography Dr. Durand indicates that such uprootings were accepted as a matter of course and that he and Mrs. Durand were happy to find lodgings as necessary.

In 1945 the Durands returned to California after four years in Washington. He writes: "Sizing myself up after this period in Washington, I found that it appeared to have taken something out of me physically. I was then 86 years of age and such a result was not to be unexpected. I then decided to settle down to a condition of full retirement."

Mrs. Durand died in 1950, and Dr. Durand is now living in Brooklyn, N. Y., near his son. It is good that he has reserved the time and energy to write this autobiography for us. It is good for the many who know this most admirable gentleman and scholar to have his life story, and it is also good for the new generation of engineers to appreciate something of the nature and flavor of the man who has done so much to prepare the way for them in their professional careers as ministers to the needs of our industrial society.

Books Received in Library

ASTM STANDARDS ON COPPER AND COPPER ALLOYS. American Society for Testing Materials, Philadelphia, Pa., 1953. 542 pp., 9 × 6 in., paper. $5. This compilation contains 115 specifications, test methods, and recommended practices pertaining to copper and copper-alloy castings, sheet, strip, bars, shapes, wire, pipe and tube, filler metal, and covered steel electrical conductors. There are also several specifications on other nonferrous metals: slab zinc, pig lead, nickel, phosphor copper, and silicon copper. The usual classified as well as numerical indexes are provided.

ASTM STANDARDS ON PLASTICS. American Society for Testing Materials, Philadelphia, Pa., 1953. 354 pp., 9 × 6 in., paper. $5.25. The 135 standards contained in this compilation include 27 specifications covering a wide range of molding compounds; a large number of test methods for strength, hardness, permanence, thermal and optical properties, molding properties, electrical tests, etc.; definitions and nomenclature; and methods for the conditioning of plastics. A classified index is provided.

ALUMINUM IN IRON AND STEEL. By Samuel L. Case and Kent R. Van Horn. John Wiley and Sons, Inc., New York, N. Y., 1953. 478 pp., $9^1/_4 \times 6^1/_4$ in., bound. $8.50. The first of a new series of alloys of iron research monographs, this book gives an exhaustive critical review of research on aluminum in modern ferrous metallurgy. It summarizes for the practical metallurgist, engineer, and foundryman essential information scattered through hundreds of journals and books in many languages. The first part provides data on the effect of small additions of aluminum to molten steel as a deoxidizer; the second part correlates research on the effect of aluminum as an alloying element in steel.

BORON STEEL. American Society for Metals. Cleveland, Ohio, second edition, 1953. 111 pp., $11^1/_8 \times 8^5/_8$ in., paper. $1. This compilation contains four papers on general aspects, seven dealing with actual experience with boron steels, two on the effect of boron on steel, and three giving supplementary technical information on hardenability tests, H-steels, and their use. There is also a data sheet giving approved specifications for the Jominy end-quench test.

BRITISH EXPRESS LOCOMOTIVE DEVELOPMENT, 1896–1948. By Edward Cecil Poultney. George Allen and Unwin, Ltd., London (distributed in U. S. by Macmillan Company, New York, N. Y., 1952. 175 pp., $10 \times 7^1/_2$ in., bound. $4.75. A history of the British express-passenger locomotive from the beginning of modern big boiler technique to the final designs of the four main line railways in 1947. Locomotives noteworthy for new departures in design and construction are described, with considerable emphasis on mechanical details and a large amount of performance data. The chapters of this book were previously published in *Modern Transport* during 1947 to 1950.

DESIGN OF MACHINE ELEMENTS. By M. F. Spotts. Prentice-Hall, Inc., New York, N.Y., second edition, 1953. 504 pp., $9^1/_4 \times 6^1/_4$ in., bound. $9.65. Beginning with a survey of prerequisite theory, this book continues with separate chapter treatments of individual machine elements. Methods based on rational analysis are utilized. Well-known basic theories are presented as well as some of the newer methods. Illustrative examples and problems are extensively used, but design data such as are usually obtained from catalogs are omitted.

THE INDUCTION MOTOR. By Herbert Vickers. Sir Isaac Pitman & Sons, Ltd., London (distributed in U. S. by Pitman Publishing Corporation, New York, N. Y.), second edition, 1953. 531 pp., $9^1/_4 \times 6^1/_4$ in., bound. $15. Theory, design, and applications are covered, with emphasis on the principles of design. In this edition additional material has been introduced in connection with single-phase machines, selsyns, three-phase series and shunt commutator motors, and the application of symmetrical components to conditions of unbalance. Fractional-hp motors are discussed, including typical designs.

INTRODUCTION TO ENGINEERING ECONOMY. By Baldwin M. Woods and E. Paul De Garmo. Macmillan Company, New York, N. Y., second edition, 1953. 519 pp., $8^1/_2 \times 5^3/_4$ in., bound. $6. A textbook for engineering students, in which the relation of such subjects as accounting, valuation, investment theory, statistical methods, and general economics to the management of engineering enterprises, is explained. The subject matter remains substantially the same as in the previous edition but the material has been revised to conform with recent developments.

INTRODUCTION TO SOLID-STATE PHYSICS. By Charles Kittel. John Wiley and Sons, Inc., New York, N. Y., 1953. 396 pp., $9^1/_4 \times 6$ in., bound. $7. Solid-state physics is a wide field concerned particularly with the special properties exhibited by atoms and molecules because of their association in the solid phase. This introductory text covers crystal structures, thermal and dielectric properties of solids, paramagnetism, ferromagnetism, superconductivity, the free electron and band theories of metals, semiconductors, and imperfections in solids. Theoretical concepts and models of solids are emphasized as being applicable to a wide range of problems.

LOW-TEMPERATURE PHYSICS. By Charles F. Squire. McGraw-Hill Book Company, Inc., New York, N. Y., 1953. 244 pp., $9^1/_4 \times 6^1/_4$ in., bound. $6.50. The properties of matter at low temperature and their adherence to quantum laws are studied. Superfluid helium, superconductivity of metals, the complex magnetic and electric permeability of matter, and the thermal energy in the solid state are extensively discussed, indicating current fields for research. Some experimental methods and apparatus are given.

LUMINESCENCE AND THE SCINTILLATION COUNTER. By S. C. Curran. Academic Press Inc., New York, N. Y., 1953. 219 pp., $8^3/_4 \times$

5¾ in., bound. $5.80. A review of current knowledge of the scintillation method of investigating atomic and nuclear radiations, written both for the incidental user of the technique and for those interested in developing its possibilities. In addition to the main subject, such related topics as secondary emission, photoelectricity, and luminescence are given detailed treatment, and a chapter on applications deals with basic problems such as gamma, neutron, and meson spectroscopy.

1952 BOOK OF ASTM STANDARDS, including Tentatives. Part 1: Ferrous Metals. 1602 pp., $12. Part 2: Nonferrous Metals. 1359 pp., $10. Part 3: Cement, Concrete, Ceramics, Thermal Insulation, Road Materials, Waterproofing, and Soils. 1666 pp., $12. Part 4: Paint, Naval Stores, Wood, Fire Tests, Sandwich Constructions, Building Constructions. 1182 pp., $10. Part 5: Fuels, Petroleum, Aromatic Hydrocarbons, and Engine Antifreezes. 1282 pp., $10. Part 6: Rubber, Plastics, and Electrical Insulation. 1520 pp., $12. Part 7: Textiles, Soap, Water, Paper, Adhesives, and Shipping Containers. 1364 pp., $10. American Society for Testing Materials, Philadelphia, Pa., 1953. 9¼ × 6¼ in., bound. $76 per set of seven parts. Now covering more than 2000 specifications, tests, etc., this new combined edition contains all of the standards, adopted and tenative, as of the present date. In order to accommodate the increased number of items the present edition is in seven volumes instead of six. Each volume is complete with detailed subject index, both classified and numerical lists of standards, and arranged to provide technologists and others with as usable a book as possible.

PHYSICAL CONSTANTS OF SOME COMMERCIAL STEELS AT ELEVATED TEMPERATURES. Edited by the British Iron and Steel Research Association. Butterworths Scientific Publications, London, England, 1953. 38 pp., 11¼ × 9 in., bound. $3.50. Total and specific heats, coefficients of thermal expansion, electrical resistivities, thermal conductivities, densities, and mean thermal diffusivities are tabulated at 50 deg intervals from 50 C up to about 1200 C for pure iron and a selection of low- and high-alloy steel. Total heat-temperature curves and expansion-temperatures curves are shown, and there is a summary of the methods used in determining the physical constants.

PLANSEE PROCEEDINGS 1952. Edited by F. Benesovsky. Metallwerk Plansee, Reutte, Tyrol (distributed in U. S. by Powder Metallurgy Bulletin, Yonkers, N. Y.) 1953. 316 pp., 9¼ × 6¼ in., bound. $8. The 29 papers presented at the first Plansee Seminar on powder metallurgy are grouped under three major headings: general and physical metallurgy and physics of solids; problems of powder metallurgy in general; cemented carbides and other hard metals. Papers are in German or English with a summary in the other language in each case.

SYMPOSIUM ON FATIGUE WITH EMPHASIS ON STATISTICAL APPROACH—II. (Special Technical Publication No. 137.) American Society for Testing Materials, Philadelphia, Pa., 1953. 91 p., 9 × 6 in., paper. $2. The four papers in this publication deal respectively with fatigue properties of steel forgings, fatigue properties and the influence of metallurgical factors, the effect of understressing on fatigue strength, and fatigue properties of large specimens.

SYMPOSIUM ON TESTING METAL POWDER AND METAL POWDER PRODUCTS. (Special Technical Publication No. 140.) American Society for Testing Materials, Philadelphia, Pa., 1953. 87 pp., 9 × 6 in., paper. $2. Among the materials and products covered in this symposium are included sintered-iron rotating bands, metal-powder gears, porous stainless-steel compacts for transpiration cooling, and cemented carbide compositions. Metal-powder size distribution and determination are discussed, and a method of specific surface measurement of metal powders is described.

TEXTBOOK OF THE MATERIALS OF ENGINEERING. By Herbert F. Moore and Mark B. Moore. McGraw-Hill Book Company, Inc., New York, N. Y., eighth edition, 1953. 372 pp., 9¼ × 6¼ in., bound. $6. Elementary in character, this book is devoted to the common materials—metals, wood, concrete, building stone, ceramics, etc.—used in structures and machines, including brief descriptions of their manufacture and fabrication. Primary emphasis is placed on the strength, toughness, and stiffness of stress-carrying materials. Information on materials which have recently been developed has been added in this new edition.

TRAILER-FLATCAR TRANSPORT. By Elwood H. Willetts, 320 Kenmore Road, Douglaston 63, L. I., N. Y., 1953. 23 pp., 11 × 8½ in., paper. $10. The economic advantages to both rail and highway carriers of line-hauling preloaded trailers on railroad flatcars are discussed, urging the co-ordination of otherwise competitive carriers. Various charts and statistical tables give such pertinent data as the actual use of flat-car service, some flat-car rates and revenues, and the ratio of motor-rail line-haul costs.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly to consider "Cases" where users have found difficulty in interpreting the Code.

These Cases pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting March 6, 1953, and approved by the Board on September 1, 1953.)

CASE NO. 1163

(Special Ruling)

Inquiry: What test pressure shall be used for shell-and-tube-type equipment such as heat-exchangers, in which tubes are rolled, welded, or brazed into tube sheets?

Reply: It is the opinion of the Committee that the test pressure for shell-and-tube-type equipment, such as heat-exchangers, in which tubes are rolled, welded, or brazed into tube sheets, shall be at least equal to but need not exceed 1½ times the design pressure stamped on the vessel multiplied by the ratio of the stress value S for the temperature of the vessel during the test to the stress value S for the design temperature.

Proposed Revisions and Addenda to Boiler and Pressure Vessel Code

AS need arises, the Boiler Code Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code.

Comments should be addressed to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.

Power Boilers
1952

TABLE P-7 Under CASTINGS add the following stress value for SA-217 Grade WC-9: 1100 F—3300 psi.

Correction

In Case No. 1114-1 on page 665 of the August, 1953, issue of MECHANICAL ENGINEERING, in paragraph 10 of the reply hydrostatic test pressure should read "1.50" and *not* "1.15."

ASME NEWS

With Notes on the Engineering Profession

1953 Annual Meeting in New York, N. Y.

Hotels Statler, McAlpin, and Governor Clinton, November 29–December 4

Preprint Orders

ONLY *preprints of ASME numbered papers will be available, November 1.* The final listing of available technical papers will be found in the issue of MECHANICAL ENGINEERING containing an account of the meeting. Preprints of ASME papers may be obtained by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 25 cents each to members; 50 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons, or coupons which may be purchased from the Society. The coupons, in lots of ten, are $2 for members; $4 for nonmembers.

Preprints of unnumbered papers, listed by title only in the tentative program, *are not available* because the review of these manuscripts had not been completed when the program went to press. The author's name and preprint number will appear with paper title in the final program (final program available only at meeting) as well as the issue of MECHANICAL ENGINEERING containing an account of the meeting, if the paper is recommended for preprinting.

Tentative Program

MONDAY, NOVEMBER 30

8:00 a.m.

Registration

9:30 a.m.

Aviation (I)—Materials Handling (I)—IAS (I)—SAE (I)—NSIA (I)—TAG (I)

Air Cargo—Ground Handling[1]

Air Cargo—Aircraft Design[1]

Air Cargo—Packaging[1]

9:30 a.m.

Applied Mechanics (I)

Reflection of Flexural Waves at the Edge of a Plate, by *Thomas R. Kane*, Columbia University (Paper No. 53—A–42)

Forced Motions of Elastic Rods, by *G. Herrmann* Columbia University (Paper No. 53—A–59)

Propagation of Elastic Impact in Beams in Bending, by *M. A. Dengler, M. Goland*, and *P. D. Wickersham*, Midwest Research Institute (Paper No. 53—A–46)

A Theory of Torsion Bending for Multicell Beams,[2] by *S. U. Benscoter*, California Institute of Technology (Paper No. 53—A–27)

9:30 a.m.

Heat Transfer (I)—Symposium on Physical Properties—Part I

Thermal Conductivity of Gases, by *F. G. Keyes*, Massachusetts Institute of Technology (Paper No. 53—A–58)

Thermal Conductivity of Some Industrial Liquids 0–100 Deg C, by *H. L. Mason*, Bureau of Standards (Paper No. 53—A–40)

An Accurate Method for the Determination of the Thermal Conductivity of Insulating Solids[1]

Thermal Conductivity of Fluids[1]

Thermal Conductivity of Some Organic Liquids[1]

9:30 a.m.

Hydraulic (I)

The Kaplan Turbine—Discussion of Design and Trends, by *J. Fisch*, S. Morgan Smith Co. (Paper No. 53—A–101)

Grand Coulee Model-Pump Investigation of Transient Pressures and Measures for Their Reduction[1]

Vibrations of the Grand Coulee Pump-Discharge Lines, by *John Parmakian*, Denver Federal Center (Paper No. 53—A–50)

9:30 a.m.

Rubber and Plastics (I)

Synthetic Rubber Protects the Navy's Propeller Shafts, by *E. A. Buksin*, Dept. of the Navy (Paper No. 53—A–126)

Hot Stretching of Nylon Tire Cord[1]

Modern Rubber Calendering Equipment[1]

9:30 a.m.

Fluid Meters (I)
Measurement of Small Flow

Coefficients of Float-Type Variable-Area Flowmeters[1]

Small Nozzles and Low Values of Diameter Ratios[1]

9:30 a.m.

Fuels (I)
The Future for Fuels

Fuel Trends in the Next Twenty Years[1]

Underground Gasification of Coal at Gorgas, Ala.[1]

Pulverized Coal-Fired Gasifier For Producing Carbon Monoxide and Hydrogen, by *P. R. Grossman* and *R. W. Curtis*, The Babcock & Wilcox Co. (Paper No. 53—A–49)

9:30 a.m.

Education (I)—Machine Design (I)—Management (I)

Deliberate Creativeness[1]

Instruction in Creative Mechanical Design[1]

9:30 a.m.

Oil and Gas Power (I)

Welded Crankshaft[1]

9:30 a.m.

Low-Temperature Flue Gas

The Use of Additives for the Prevention of Low-Temperature Corrosion in Oil-Fired Steam-Generating Units[1]

12:15 p.m.

President's Luncheon

2:30 p.m.

Aviation (II)—Materials Handling (II)—IAS (II)—SAE (II)—NSIA (II)—TAG (II)

Commercial Airlift for Economical Air Logistics[1]

The Combination Air-Carrier's Approach to Air-Freight Service[1]

2:30 p.m.

Applied Mechanics (II-A)

Dynamic Behavior of Reinforced Cylindrical Shells in a Vacuum and in a Fluid, by *M. C. Junger*, Harvard University (Paper No. 53—A–1)

Free and Forced Vibrations of an Infinitely Long Cylindrical Shell in an Infinite Acoustic Medium, by *H. H. Bleich* and *M. L. Baron*, Columbia University (Paper No. 53—A–37)

On the Equations of Motion of Cylindrical Shells, by *P. M. Naghdi* and *J. G. Berry*, University of Michigan (Paper No. 53—A–34)

Tables for the Frequencies and Modes of Free Vibration of Infinitely Long Thin Cylindrical Shells,[2] by *M. L. Baron* and *H. H. Bleich*, Columbia University (Paper No. 53—A–33)

2:30 p.m.

Heat Transfer (II)—Symposium on Physical Properties—Part II

The Theoretical Calculation of the Equation of State and Transport Properties of Gases and Liquids, by *R. B. Bird, J. O. Hirschfelder*, and *C. F. Curtiss* (Paper No. 53—A–87)

Tabulation of Imperfect-Gas Properties for Air, Nitrogen, and Oxygen, by *N. A. Hall* and *W. E. Ibele* (Paper No. 53—A–5)

Generalized PVT Properties of Gases[1]

2:30 p.m.

Hydraulic (II-A)

Performance of the Turbulence Pump, by *H. W. Iversen*, University of California (Paper No. 53—A–102)

The Effect of Heating on Boundary-Layer Transition for Liquid Flow in a Tube[1]

2:30 p.m.

Rubber and Plastics (II)

Dynamic Characteristics of Silicone Rubber, by *G. W. Painter*, Lord Manufacturing Co. (Paper No. 53—A–88)

Mechanical Properties of Polysulphide Rubbers[1]

The Versatility of Cellular Rubber in Engineering, by *G. R. Sprague, A. F. Sereque, J. J. Corrigan*, and *J. L. Gertz*, Sponge Rubber Products Co. (Paper No. 53—A–127)

[1] See box on this page.
[2] Presented by title only.

Selected Rubber References for the Mechanical Engineer: July, 1952–June, 1953[1]

2:30 p.m.

Fluid Meters (II)

Pulsation Measurement and Control

Pulsating-Flow Measurement—A Literature Survey[1]

Pulsation Absorbers for Reciprocating Pumps, by *E. G. Chillon* and *L. R. Handley,* Shell Development Co. (Paper No. 53—A–81)

2:30 p.m.

Gas Turbine Power (I)—Hydraulic (II-B)

Compressor Surge and Stall Propagation, by *H. W. Emmons, C. E. Pearson,* and *H. P. Grant,* Harvard College (Paper No. 53—A–65)

Basic Compressor Characteristics From Tests of a Two-Stage Axial-Flow Machine[1]

2:30 p.m.

Metals Engineering (I)—Applied Mechanics (II-B)

Quantitative Evaluation of Thermal Shock Resistance[1]

Evaluation of Transient Temperatures and Stresses, by *Robert J. Fritz,* General Electric Co. (Paper No. 53—A–75)

An Apparatus for the Study of the Effects of Cyclic-Thermal Stresses on Ductile Metals, by *L. F. Coffin, Jr.,* and *R. P. Wesley,* General Electric Co. (Paper No. 53—A–77)

Study of the Effects of Cyclic-Thermal Stresses on a Ductile Metal, by *L. F. Coffin, Jr.,* General Electric Co. (Paper No. 53—A–76)

2:30 p.m.

Fuels (II)

Solving Present-Day Fuel Problems

Fuel-Oil Specifications[1]

Boiler and Furnace Design for Spreader Stokers[1]

Storage Changes as They Influence the Oil Picture[1]

Interface Extension Versus Upper Limiting Time-Mean-Energy Release Rates of the Constant-Pressure Steady-State Combustion Process,[2] by *W. J. Wohlenberg,* Yale University (Paper No. 53—A–103)

2:30 p.m.

Education (II)—Management (II)

Simplified Drafting Practice—Industry Viewpoint[1]

Simplified Drafting Practice—College Viewpoint[1]

4:00 p.m.

Tea Dance

4:45 p.m.

Business Meeting

8:00 p.m.

Aviation (III)—Gas Turbine Power (II)—SAE (III)

Development of the Turboprop Military[1]

Turbocyclone Compound Engine[1]

8:00 p.m.

Applied Mechanics (III-A)

Stresses in a Metal Tube Under Both High Radial Temperature Variation and Internal Pressure, by *Chieh C. Chang* and *Wan H. Chu,* University of Maryland (Paper No. 53—A–4)

On the Strain Energy of Shells, by *H. L. Langhaar* and *D. R. Carver,* Kansas State College (Paper No. 53—A–10)

Stresses and Deformations of Flanged Shells, by *G. Horvay* and *I. M. Clausen,* Knolls Atomic Power Laboratory (Paper No. 53—A–43)

Stress Concentrations Around a Small Spherical or Spheroidal Inclusion on the Axis of a Circular Cylinder in Torsion,[2] by *S. Chandra Das,* Chandermagore College (Paper No. 53—A–2)

8:00 p.m.

Heat Transfer (III)—Symposium on Physical Properties—Part III

Viscosity, Thermal Conductivity, and Prandtl Number for Air, Nitrogen, Oxygen, Hydrogen, Argon, Carbon Monoxide, Carbon Dioxide, Nitric Oxide, Steam, and Helium[1]

Measurement of the Viscosity of Five Gases at Elevated Pressures by the Oscillating-Disk Method, by *J. Kestin* and *K. Pilarczyk* (Paper No. 53—A–67)

Preliminary Note on the Correlation of the Viscosities of Gases and Other Fluids[1]

Compressibility of Gases VIII Krypton 0–600 Deg C and 10–80 Atmospheres, by *E. Whalley* and *W. G. Schneider* (Paper No. 53—A–85)

8:00 p.m.

Metals Engineering (II)—Applied Mechanics (III-B)

Thermal Shocking of Type-347 Stainless-Steel Piping With Liquid Metals[1]

Thermal Stress Relieving in Type-347 Stainless Steel[1]

Thermal Checking of Wrought-Steel Railway-Wheel Material, by *H. R. Wetenkamp,* University of Illinois (Paper No. 53—A–72)

Determination of the Thermal Conductivity of Molten Lithium, by *H. A. Webber, D. Goldstein,* Iowa State College, and *R. C. Fellinger,* Sylvania Electric Products, Inc. (Paper No. 53—A–79)

8:00 p.m.

Junior—Management (III)

Panel on Formal Industry-Training Program Compared With "On-the-Job Training" of Young Engineers

On Job Training[1]

Formal Industry-Training Programs[1]

Panel Members

8:00 p.m.

Fuels (III)

Handling Combustion-Waste Products

Chimney Design, by *R. H. Sherlock,* University of Michigan (Paper No. 53—A–80)

Economics of Ash Handling, by *L. E. Mylting,* Allen-Sherman Hoff Co. (Paper No. 53—A–48)

Electrostatic Precipitators[1]

8:00 p.m.

Power Test Codes

Symposium on Evaluation of Experimental Uncertainty and Design of Engineering Experiments

Some Statistical Methods for Evaluation of Experimental Results[1]

Design of Power-Plant Tests[1]

Measurement Errors: Classification and Interpretation[1]

TUESDAY, DECEMBER 1

8:00 a.m.

Registration

9:30 a.m.

Aviation (IV)—Materials Handling (III-A)—IAS (III)—SAE (IV)—NSIA (III)—TAG (III)

Ground Movement of Air Cargo[1]

The Missing Link in the Air-Cargo Chain[1]

9:30 a.m.

Applied Mechanics (IV-A)

The Analysis of the Plastic Deformation in a Steel Cylinder Striking a Rigid Target, by *E. H. Lee,* Brown University, and *S. J. Tupper,* Armaments Research Establishment, Ministry of Supply, Fort Halstead, Sevenoaks, Kent, England (Paper No. 53—A–28)

Coulomb Friction, Plasticity, and Limit Loads, by *D. C. Drucker,* Brown University (Paper No. 53—A–57)

The Plasticity of an Isotropic Aggregate of Anisotropic Face-Centered Cubic Crystals, by *A. V. Hershey,* U. S. Naval Proving Ground (Paper No. 53—A–63)

Creep Tests of Rotating Disks at Elevated Temperature and Comparison With Theory, by *A. M. Wahl, G. O. Sankey, M. J. Manjoine,* and *E. Shoemaker,* Westinghouse Electric Corp. (Paper No. 53—A–61)

The Elasticity of an Isotropic Aggregate of Anisotropic Cubic Crystals,[2] by *A. V. Hershey,* U. S. Naval Proving Ground (Paper No. 53—A–62)

Plastic Flow in a Rectangularly Notched Bar Subjected to Tension,[2] by *E. H. Lee,* Brown University (Paper No. 53—A–29)

9:30 a.m.

Instruments and Regulators (I)—Frequency-Response Symposium—Part 1

Introduction to the Frequency-Response Symposium, by *Rufus Oldenburger,* Woodward Governor Co.[1]

Frequency-Response Data—Presentation Standards and Design Criteria, by *Rufus Oldenburger,* Woodward Governor Co. (Paper No. 53—A–11)

Sine-Wave Generators, by *D. W. St. Clair,* Eastman Kodak Co., *L. W. Erath,* SW Industrial Electronics Co., and *S. L. Gillespie,* Woodward Governor Co. (Paper No. 53—A–12)

A Bibliography of the Frequency-Response Method as Applied to Automatic Feedback-Control Systems,[2] by *A. M. Fuchs,* Bendix Aviation Corp. (Paper No. 53—A–13)

9:30 a.m.

Heat Transfer (IV)

Convective Heat Transfer for Mixed Free and Forced Flow Through Tubes[1]

Heat Transfer to Mercury in Turbulent Pipe Flow[1]

Heat Transfer to Lead-Bismuth and Mercury in Laminar and Transition Pipe Flow[1]

The Effect of Single Roughness Elements on Heat Transfer From a 1:3 Elliptical Cylinder, by *R. A. Seban, S. Levy, D. L. Doughty,* and *R. M. Drake, Jr.* (Paper No. 53—A–86)

9:30 a.m.

Hydraulic (III)

Visualization Studies of Secondary Flows With Applications to Turbomachines, by *H. Z. Hersig* and *A. G. Hansen,* Lewis Flight Propulsion Laboratory (Paper No. 53—A–56)

The Analysis and Evaluation of Compressor Performance, by *M. C. Stuart* and *T. E. Jackson,* Lehigh University (Paper No. 53—A–53)

9:30 a.m.

Power (I)—Applied Mechanics (IV-B)—SNAME

Turbine-Generator Sets for Shipboard Service, by *A. G. Gale* and *H. J. Chase,* General Electric Co. (Paper No. 53—A–89)

Turbine-Blade Vibration and Strength, by *W. E. Trumpler, Jr.,* and *H. M. Owens* (Paper No. 53—A–98)

Comparison of Land and Marine Power-Plant Practices, by *M. L. Ireland, Jr., F. A. Ritchings, Jr.,* and *Sabine Crocker* (Paper No. 53—A–99)

9:30 a.m.

Rubber and Plastics (III)

Mechanical Properties of Polymethyl Methacrylate, by *J. K. Knowles* and *Albert G. H. Dietz,* Massachusetts Institute of Technology (Paper No. 53—A–100)

Reinforced Plastic Laminates for Aircraft Use[1]

9:30 a.m.

Gas Turbine Power (III)—Fuels (IV)

A Panel Discussion Covering Residual Fuels in the Gas-Turbine Industry

9:30 a.m.

Management (IV)—Materials Handling (III-B)—Metal Processing (I)—Petroleum (I)—Process Industries (I)—Production Engineering (I)

Symposium on the Problems of Management in the Automatic-Factory Age

Part 1—Problems of Engineering

Engineers, Engineering, and the Automatic Factory[1]

Management of Engineers[1]

Training of Engineers for Automatic Production[1]

9:30 a.m.

Oil and Gas Power (II)

Panel on Filtration of Fuel Oil

12:15 p.m.

Instruments and Regulators Luncheon

Presiding: *S. G. Eskin,* technical adviser, Dole Valve Co., Chicago, Ill.

---

[1] See box on page 836.
[2] Presented by title only.

Speaker: *H. Nyquist*, assistant director of system studies, Bell Telephone Laboratories, New York, N. Y.

Subject: **My 1932 Paper on Regeneration Theory**

Speaker: *A. C. Hall*, technical director, Research Laboratories, Bendix Aviation Corp., Detroit

Subject: **Early History of the Frequency-Response Field**

12:15 p.m.

Heat Transfer Luncheon

Presiding: *P. R. Trumpler*, mechanical-engineering department, Illinois Institute of Technology

Speaker: *O. A. Saunders*, Imperial College, University of London

Subject: To be announced

12:15 p.m.

Aviation Luncheon

12:15 p.m.

Fuels Luncheon

Presiding: *J. R. Michel*, Commonwealth Edison Co., Chicago, Ill.

Speaker: *Alfred Iddles*, president, The Babcock & Wilcox Co., New York, N. Y.

Subject: **Power Today and Tomorrow**

2:30 p.m.

Aviation (V)—Production Engineering (II-A)—SAE (V)—IAS (IV)

Operating Results With a 14,000-Ton Capacity Extrusion Press[1]

Weight Savings From the Use of Heavy Presses[1]

2:30 p.m.

Nuclear Energy

Panel: Progress Toward Industrial Atomic Power

Background and Present Status of the Industrial Atomic Power Studies[1]

A Reactor Engineer Looks at the Problem[1]

The Problem From an Economic Standpoint[1]

The Legal Barrier[1]

Statement of AEC Policy[1]

2:30 p.m.

Applied Mechanics (V)

Bending of Circular and Ring-Shaped Plates on an Elastic Foundation, by *Herbert Reismann*, Consolidated Vultee Aircraft Corp. (Paper No. 53—A–7)

A Numerical Solution for the Nonlinear Deflection Membranes, by *F. S. Shaw* and *N. Perrone*, Polytechnic Inst. of Brooklyn (Paper No. 53—A–36)

Bending of Isotropic Thin Plates by Concentrated Edge Couples and Forces, by *Yi-Yuan Yu*, Washington University (Paper No. 53—A–32)

On Bending of a Flat Slab Clamped in Square-Shaped Columns,[2] by *S. Woinowsky-Krieger*, Laval University (Paper No. 53—A–60)

Stress Concentrations Due to Elliptical Holes in Orthotropic Plates,[2] by *H. D. Conway*, Cornell University (Paper No. 53—A–30)

2:30 p.m.

Railroad (I)—Oil and Gas Power (III)

Hydraulic Transmissions for Locomotives, by *J. S. Newton*, Baldwin-Lima-Hamilton Corp. (Paper No. 53—A–122)

Standardization of Diesel Locomotives, by *C. K. Steins*, The Pennsylvania Railroad (Paper No. 53—A–105)

2:30 p.m.

Instruments and Regulators (II)—Frequency-Response Symposium—Part 2

Determination of Transient Response From Frequency Response, by *A. Leonhard*, Stüttgart Institute of Technology (Paper No. 53—A–14)

The Analysis of Regulating Systems, With Particular Reference to Speed Control, by *R. H. MacMillan*, Cambridge University (Paper No. 53—A–15)

The Application of Frequency-Analysis Techniques to Hydraulic-Control Systems, by *Albert C. Hall*, Bendix Aviation Corp. (Paper No. 53—A–16)

[1] See box on page 836.
[2] Presented by title only.

2:30 p.m.

Hydraulic (IV)

Noise Control in Industrial Areas—Principles and Practices, by *W. A. Jack*, Johns-Manville Research Center (Paper No. 53—A–55)

Silencers for Compressors, by *R. B. Bourne*, Maxim Silencer Co. (Paper No. 53—A–54)

2:30 p.m.

Heat Transfer (V-A)

Heat Transfer in a Gas-Fired Furnace[1]

A Review of Thermal Radiation Constants[1]

Radiation in Metals[1]

Thermal Radiation Tables and Applications[1]

2:30 p.m.

Power (II)—Fuels (V)

Panel

Manpower and Other Factors Affecting Operating Costs, by *V. F. Estcourt*, Pacific Gas & Electric Co. (Paper No. 53—A–95)

Panel Members

J. C. Falkner, Consolidated Edison Co., New York

W. V. Drake, West Penn Power Co., Pittsburgh, Pa.

G. V. Williamson, Union Electric Power and Light Co., St. Louis, Mo.

J. D. Williamson, Dayton Power & Light Co., Dayton, Ohio

2:30 p.m.

Rubber and Plastics (IV)

Speedylectric Electrode Boiler—A New Method of Supplying Heat at Calenders and Platens [1]

New Developments in Liquid Heating of Plastics-Processing Machinery, by *P. L. Geiringer* and *Floyd Hesselriis*, American Hydrotherm Corp. (Paper No. 53—A–68)

Selected Plastics References for the Mechanical Engineer—July 1952–June 1953[1]

2:30 p.m.

Gas Turbine Power (IV)—Heat Transfer (V-B)

The Gas Turbine as a Prime Mover in U. S. Navy Ships[1]

A 4500-Kw Mobile-Power Gas-Turbine Power Plant[1]

2:30 p.m.

Management (V)—Materials Handling IV—Metal Processing (II)—Petroleum (II)—Process Industries (II)—Production Engineering (II-B)

Symposium on the Problems of Management in the Automatic-Factory Age

Part 2—Problems of Economics

Economics of Equipment Replacement[1]

What Makes Automation Pay?[1]

Control of Production of the Automatic Factory[1]

5:00 p.m.

Towne Lecture

Speaker: *Philip M. McKenna*, president, Kennametal, Inc., Latrobe, Pa.

Subject: **Economics and the Engineer**

6:00 p.m.

Applied Mechanics Dinner

Presiding: *Dana Young*, chairman, Applied Mechanics Division, Department of Civil Engineering, Yale University, New Haven, Conn.

Speaker: *Alan T. Waterman*, director, National Science Foundation, Washington, D. C.

Subject: **Progress Report on the National Science Foundation**

6:30 p.m.

Hydraulic Old Timers' Dinner

Presiding: *J. Frank Roberts*, vice-president and director of engineering, Allis-Chalmers Co.

8:00 p.m.

Instruments and Regulators (III)—Frequency-Response Symposium—Part 3

The Synthesis of Optimum Feedback Systems Satisfying a Power Limitation, by *J. H. Westcott*, Imperial College of Science and Technology, London, England (Paper No. 53—A–17)

A Uniform Approach to the Optimum Adjustment of Control Loops, by *Rudolf C. Oldenbourg*, R. Oldenbourg, Inc., and *Hans Sartorius*, editor, *Regelungs Technik*, Hersbruch, b. Nürnberg, Germany (Paper No. 53—A–18)

Recent Advances in Nonlinear Servo Theory, by *J. M. Loeb*, Centre National d'Etudes des Telecommunications, Paris, France (Paper No. 53—A–19)

A Statistical Approach to Servomechanisms and Regulators, by *M. J. Pelegrin*, Service Technique Aeronautique, Paris, France (Paper No. 53—A–20)

8:00 p.m.

Power (III)—Furnace Performance Factors—Fuels (VI)—Metals Engineering (III)—Effect of Temperature on Metals (I)—High-Temperature Steam Generation (I)

The Controlled-Circulation Boiler, by *W. H. Armacost*, Combustion Engineering, Inc. (Paper No. 53—A–91)

Controlled Circulation at Chesterfield, by *T. E. Crossan*, Virginia Electric & Power Co., and *W. F. Ryan*, Stone & Webster Engineering Corp. (Paper No. 53—A–96)

The New Kearny Generating Station, by *F. P. Fairchild*, Public Service Electric & Gas Co (Paper No. 53—A–71)

Reheat Turbines at Chesterfield and Kearny Stations, by *C. W. Elston*, General Electric Co. (Paper No. 53—A–92)

8:00 p.m.

Management (VI)—Materials Handling (V)—Metal Processing (III-A)—Petroleum (III)—Process Industries (III)—Production Engineering (III)

Symposium on the Problems of Management in the Automatic-Factory Age

Part 3—Problems of Organization

Techniques of Management Control[1]

Management Organization With Automatic Production[1]

8:00 p.m.

Aviation (VI)—Metal Processing (III-B)

Recent Design of Stretching Machines for Straightening and Detwisting Extruded Shapes[1]

Recent Developments and Trends in Step and Taper Extrusions[1]

8:00 p.m.

Machine Design (II)

A Concept of Fatigue Damage[1]

Synthesis of the Quadric Chain When the Position of Two Members Is Prescribed[1]

Linkage Design, a Note on One Method[1]

WEDNESDAY, DECEMBER 2

8:00 a.m.

Registration

9:30 a.m.

Aviation (VII-A)—SAE (VI)

Mechanical Features of the Tandem Helicopter Drive[1]

Design and Development Problems in a Large Helicopter Power-Transmission System[1]

9:30 a.m.

Railroad (II)—Lubrication (I)

Annual Report of Engineering Progress, by *T. F. Perkinson*, General Electric Co. (Paper No. 53—A–120)

Symposium on the Technical Aspects of the Hotbox Problem

The Hogan Antiwaste Roll Cavity and Ledge Journal Box, by *B. R. Jones*, Hartford Railroad Co. (Paper No. 53—A–106)

Packing Retainer for Railroad-Car Journal Boxes, by *H. J. Stewart*, Union Spring and Manufacturing Co. (Paper No. 53—A–107)

Spring-Type Packing Retainer for Journal Boxes (Color sound movie—15 min.), by *M. F. Brunner*, Spring Packing Corp. (Paper No. 53—A–108)

A New Mechanical Oiler for Car Journals, by *V. E. McCoy*, St. Paul and Pacific Railroad Co. (Paper No. 53—A–109)

Modernizing Journal Lubrication, by *Karl Klingler,* Roth Rubber Co. (Paper No. 53—A-110)

The Plypak Waste Container and Retainer, by *J. W. Hulson,* Waugh Equipment Co. (Paper No. 53—A-123)

(To be continued at 2:30 p.m. Wed., Dec. 2)

9:30 a.m.

Applied Mechanics (VI)

The Stresses in a Flat Curved Bar Due to Concentrated Tangential Boundary Loads, by *Ning-Gau Wu,* Jacuzzi Brothers, Inc., and *Carl W. Nelson,* University of California (Paper No. 53—A-47)

Stress Concentration Due to a Hemispherical Pit at a Free Surface, by *R. A. Eubanks,* Illinois Institute of Technology (Paper No. 53—A-8)

Contact of Elastic Spheres Under an Oscillating Torsional Couple, by *H. Deresiewicz,* Columbia University (Paper No. 53—A-31)

Transmission of Tension From a Bar to a Plate, by *J. N. Goodier,* Stanford University, and *C. S. Hsu,* International Business Machines Corp. (Paper No. 53—A-41)

9:30 a.m.

Instruments and Regulators (IV)—Frequency-Response Symposium—Part 4

Control-System Behavior Expressed as a Deviation Ratio, by *J. M. L. Janssen,* Royal-Dutch Shell Laboratory, Delft, Holland (Paper No. 53—A-21)

Frequency-Response Analysis and Controllability of a Chemical Plant, by *A. R. Aikman,* Imperial Chemical Industries, Ltd., London, England (Paper No. 53—A-22)

Frequency-Response Method Applied to the Study of Turbine Regulation in the Swedish Power System, by *V. Oja,* Aros Electric, Inc. (Paper No. 53—A-23)

9:30 a.m.

Heat Transfer (VI-A)

Local Boiling Heat Transfer to Water at Low Reynolds Number and High Pressures[1]

Kinetic Theory of Evaporation Rates of Liquids[1]

Design Calculations for a Tubular Air Heater[1]

Heat Transfer and Fluid Friction During Flow Across Banks of Tubes: V—Baffled Exchanger With No Internal Leakage[1]

9:30 a.m.

Hydraulic (V-A)—Aviation (VII-B)

Controls and Safety Devices for Operating Heavy Presses[1]

Capacities and Size of Equipment in Accumulator Stations for Heavy-Press Operations, by *A. F. Welsh,* Worthington Corp. (Paper No. 53—A-128)

9:30 a.m.

Power (IV)—Fuels (VII)—Hydraulic (V-B)

Symposium on Design for and Experience With Outdoor Power Plants

J. N. Landis, vice-president Bechtel Corp., San Francisco, Calif.

F. W. Argue, assistant chief engineer, Stone & Webster Engineering Corp., Boston, Mass.

E. C. Duffy, electrical production manager, Long Island Lighting Co., Mineola, L. I., N. Y.

W. F. Friend, mechanical engineer, Ebasco Services, Inc., New York, N. Y.

A. B. Martin, Montana Power Co., Butte, Mont.

V. F. Estcourt, general superintendent of steam generation, Pacific Gas & Electric Co., San Francisco, Calif.

9:30 a.m.

Gas Turbine Power (V)—Heat Transfer (VI-B)

Pin-Fin Heat-Exchanger Surfaces[1]

Utilization of Heat-Transfer Surface in the Counterflow Regenerator[1]

9:30 a.m.

Metals Engineering (IV)

Preliminary Investigation on the Effect of Sequence on Cold Cylindrical Steel Rods Through Dies—Part I, by *Harry Majors,* University of Alabama (Paper No. 53—A-73)

Effect of Sequence on Cold Drawing 2 S-O Aluminum Rod Through Dies—Part 2, by *Harry Majors,* Univ. of Alabama (Paper No. 53—A-74)

The Effect of Dispersions on the Creep Property of Aluminum Copper Alloys, by *W. A. Giedt, O. D. Sherby,* and *John E. Dorn,* University of California (Paper No. 53—A-78)

9:30 a.m.

American Rocket Society (I)

Rocket and Turbine Testing

Experimental Testing Techniques of Extremely High-Thrust Rocket-Propulsion Systems, by *R. F. Gompertz* (ARS Paper No. 104—53)

Test Thrust Chambers for the Evaluation of Rocket-Chamber Characteristics, by *J. R. Piselli* (ARS Paper No. 105—53)

Multidirection Vibration Tester, by *A. Bohr* (ARS Paper No. 106—53)

9:30 a.m.

Management (VII)

Linear Programming as a Management Tool[1]

Industrial Applications of Linear Programming[1]

Wage-Incentive Design for Multiple Machine Assignments Having Planned Servicing Savings[1]

12:15 p.m.

Honors Luncheon

Presiding: *Frederick S. Blackall, jr.,* Retiring President ASME

Inauguration of Machine-Tool and Economic-Value Awards. Established by the National Machine Tool Builders' Association.

Address: *Herbert L. Tigges,* president, National Machine Tool Builders' Assn.

Announcement of Recipients: *Robert M. Van Duzer, Jr.,* chairman, ASME Board on Honors

Presentation of Awards: *Lewis K. Sillcox,* Incoming President ASME

Presentation of Gantt Medal

Introduction of the Recipient: *J. Keith Louden,* Mem. ASME, chairman of Gantt Medal Board

ROY V. WRIGHT LECTURE

The Medallist, *Thomas Millsop,* president, Weirton Steel Co.

2:30 p.m.

Air-Pollution Controls—Fuels (VIII)—Power (V-A)

Air-Pollution Control in Canada[1]

Air-Pollution Control in New York[1]

Air-Pollution Control in Great Britain[1]

Air-Pollution Control in Los Angeles[1]

2:30 p.m.

Aviation (VIII)—SAE (VII)

Dimensional Stability and Other Structural Aspects of Casting for Aircraft Gas Turbines[1]

Characteristics of a Vaporizing Combuster for Aviation-Gas Turbines[1]

2:30 p.m.

Railroad (III)—Lubrication (II)

Symposium on the Technical Aspects of the Hotbox Problem

(Continued from 9:30 a.m. Session, Wed. Dec. 2)

Effect of Viscosity on Car Journal Oils on the Running Temperature and Other Characteristics of Journal-Bearing Performance, by *W. M. Keller,* Association of American Railroads (Paper No. 53—A-111)

Hotboxes—Some Fundamental Problems, by *J. W. Hawthorne,* Atlantic Coast Line Railroad Co. (Paper No. 53—A-104)

Effects of Off-Center Brake-Rod Pull on the Performance of Railroad Freight-Car Trucks, by *H. T. Rockwell,* New York Central System (Paper No. 53—A-112)

Hotboxes and Train Operation, by *G. R. Anderson,* Chicago & North Western Railway Co. (Paper No. 53—A-124)

2:30 p.m.

Applied Mechanics (VII)

On the Thickness of Normal Shock Waves in a Perfect Gas, by *A. H. Shapiro,* Massachusetts Institute of Technology, and *Stephen J. Kline,* Stanford University (Paper No. 53—A-35)

Flexibility of Piping Systems Supported by Equally Spaced Rigid Hangers, by *J. E. Brock,* Midwest Piping Company, Inc. (Paper No. 53—A-6)

An Application of a Quasi-Static Variational Principle to a System With Damping, by *Morris Morduchow,* Polytechnic Institute of Brooklyn (Paper No. 53—A-3)

The Stepped Thrust Bearing—A Solution by Relaxation Methods,[2] by *C. F. Kettleborough,* University of Melbourne (Paper No. 53—A-9)

2:30 p.m.

Instruments and Regulators (V)—Frequency-Response Symposium—Part 5

The Use of Zeros and Poles for Frequency Response or Transient Response, by *Walter R. Evans,* North American Aviation Co. (Paper No. 53—A-24)

Approximate Frequency-Response Methods for Representing Saturation and Dead Band, by *Harold Chestnut,* General Electric Co. (Paper No. 53—A-25)

Stability Characteristics of Closed-Loop Systems With Dead Band, by *C. H. Thomas,* General Electric Co. (Paper No. 53—A-26)

2:30 p.m.

Heat Transfer (VII)

Symposium on Attachment of Tubes to Tube Sheets

Tube Expanding and Related Subjects[1]

Welding and Brazing of Tubes to Tube Sheets for Unfired Heat-Transfer Equipment[1]

The Electronic Control Method for the Precision Expanding of Tubes[1]

2:30 p.m.

Power (V-B)

The Economics of Large Turbine-Exhaust End-Size Selection for Electric Power Generation, by *D. W. R. Morgan, Jr.,* and *S. D. Fulton,* Westinghouse Electric Corp. (Paper No. 53—A-93)

Economic Determination of Condenser and Turbine-Exhaust Sizes, by *E. H. Miller,* General Electric Co., and *A. Sidun,* Foster Wheeler Corp. (Paper No. 53—A-94)

2:30 p.m.

American Rocket Society (II-A)

Rocket and Turbine Testing

Introduction to the Analysis of Supersonic Ramjet Power, by *G. A. Sears* and *B. W. Marsh* (ARS Paper No. 103—53)

The Problem of Cooling a Rocket Flame Deflector, by *T. F. Reinhardt* (ARS Paper No. 107—53)

Design and Construction of a 350,000-Lb Thrust Rocket Test Stand,[1] by *B. N. Abramson, D. S. Brandwein,* and *H. C. Menes* (ARS Paper No. 108—53)

A Bolometer for Measurement of Turbine-Blade Temperatures in Flight, by *H. C. Menes* (ARS Paper No. 109—53)

2:30 p.m.

American Rocket Society (II-B)

Rocket Motor Design

Some Problems Associated With the Design and Development of Liquid Bi-Propellant Rocket-Engine Installations, by *H. J. Jansen, R. R. Duance,* and *H. A. Ferullo* (ARS Paper No. 110—53)

Some Aspects of Design and Fabrication of Liquid-Propellant Engines, by *H. Davies* (ARS Paper No. 111—53)

The Fine Points in Rocket Preliminary Design and Proposal Preparation, by *S. Lehrer* (ARS Paper No. 112—53)

Gas-Torch Igniters for Rocket Engines, by *G. Woodruff* (ARS Paper No. 113—53)

2:30 p.m.

Production Engineering (IV)—Management (VIII)

Application of Quality-Control Requirements for a Coaxial Carrier System[1]

Quality Control for Cartridges[1]

Trouble Shooting for Quality[1]

2:30 p.m.

Gas Turbine Power (VI)

A Novel Method of Cooling Turbine Blades[1]

Free-Piston Turbine Compound Engine—A Cycle Analysis[1]

[1] See box on page 836.
[2] Presented by title only.

7:00 p.m.

Banquet

Speaker: *Gwilym A. Price*, president, Westinghouse Electric Corp., Pittsburgh, Pa.

THURSDAY, DECEMBER 3

8:00 a.m.

Registration

9:30 a.m.

Railroad (IV)—ASTM (I)

Symposium on Railway Steel Wheels

Wrought-Steel Passenger-Car Wheels From a Consumer's Standpoint, by *A. M. Johnsen*, The Pullman Co. (Paper No. 53—A-113)

Measurement of Stresses Imposed on Wheels in Diesel Locomotive Service, by *L. L. Olson*, Association of American Railroads (Paper No. 53—A-114)

Wheel Performance With Disk Brakes, by *P. V. Garin*, Southern Pacific Co. (Paper No. 53—A-115)

Wheel Defects in Equipment With Clasp Brakes, by *M. S. Riegel*, New York Central System (Paper No. 53—A-116)

Railroading Today Through the Eyes of the Wheel Manufacturer, by *C. B. Bryant*, Wheel Industry (Paper No. 53—A-117)

(To be continued at 2:30 p.m. Thurs., Dec. 3)

9:30 a.m.

Applied Mechanics (VIII)—SESA (III)

Torsional Vibration of a Thin-Walled Tube With a Large Mass at the Tip[1]

The Experimental Measurement of Mechanical Impedance or Mobility, by *R. Plunkett*, General Electric Co. (Paper No. 53—A-45)

A Method for Determining the Internal Damping of Machine Members, by *A. W. Cochardt*, Westinghouse Research Laboratories (Paper No. 53—A-44)

9:30 a.m.

Power (VI)—Boiler Feedwater Studies (I)

Testing Large Steam Turbines With Weighing Tanks, by *W. A. Pollock*, Wisconsin Electric Power Co. (Paper No. 53—A-66)

A Short Method for the Evaluation of the Effect of Some Terminal Cycle Variations on Steam-Turbine Heat Rates, by *S. D. Fulton*, Westinghouse Electric Corp. (Paper No. 53—A-97)

The Solubility of Nitrogen and Hydrogen in Water, by *W. L. Sibbitt*, Purdue University, *L. M. Zoss*, Taylor Instrument Co., and *S. Sucin*, General Electric Co. (Paper No. 53—A-64)

9:30 a.m.

Metal Processing (IV)

Fundamental Factors in the Machining and Grinding of Titanium[1]

On the Theory of Regenerative Chatter in Precision-Grinding Operations[1]

9:30 a.m.

American Rocket Society (III-A)

Thermodynamics, Fluid Flow, Heat Transfer

One-Dimensional Steady Adiabatic Flow in a Constant-Area Channel With Mass Addition at Constant Enthalphy and Negligible Kinetic Energy, by *E. W. Price* (ARS Paper No. 101—53)

The Isothermal Compressibilities of Some Rocket Propellant Liquids and the Ratio of Specific Heats, by *G. Kretschmar* (ARS Paper No. 100—53)

Investigation of Boiling Heat Transfer and Burnout of JP-4, by *C. M. Beighley* (ARS Paper No. 114—53)

Heat-Transfer and Fluid-Friction Characteristics of White Fuming Nitric Acid, by *B. A. Reese* and *G. Graham* (ARS Paper No. 102—53)

9:30 a.m.

American Rocket Society (III-B)

Liquid Properties, Handling, and Analytical Procedures

Static Seal for Low-Temperature Fluids, by *S. E. Logan* (ARS Paper No. 115—53)

Pumping Hydrogen Peroxide, by *N. S. Davis* and *R. Bloom* (ARS Paper No. 116—53)

Equipment for the Field Handling of Concentrated Hydrogen Peroxide, by *J. Keefe* and *R. Klee* (ARS Paper No. 117—53)

Safety Clothing for Personnel Handling Concentrated Hydrogen Peroxide, by *J. Keefe* and *J. Nowak* (ARS Paper No. 118—53)

9:30 a.m.

Safety (I)—Management (IX)

Importance of Safety to Engineering Students[1]

Organized for Safety[1]

Noisome Noise—What Are Its Limits?[1]

Human-Engineering Aspects of Safety[1]

9:30 a.m.

Lubrication (III)—Oil and Gas Power (IV)

Catalytic Action in the Oxidation of Lubricating Oils[1]

The Development and Application of Antiwear Turbine Oils, by *T. W. Hazely* and *A. R. Black*, Shell Oil Co. (Paper No. 53—A-125)

9:30 a.m.

Machine Design (III)

Automatic Control—Principles of Feedback and Their Application in Machine Control[1]

Mechanical Analog Computing Elements and Their Applications to Automatic Control[1]

9:30 a.m.

Production Engineering (V)

Testing Methods for Production of Accurate Machine Slide Ways, by *George N. Levesque*, Brown and Sharpe Manufacturing Co. (Paper No. 53—A-69)

12:15 p.m.

Members and Students Luncheon

2:30 p.m.

Railroad (V)—Metal Processing (V-A)—ASTM (II)

Pressure-Pouring Steel Car Wheels in Permanent Molds, by *E. Q. Sylvester*, Griffin Wheel Co. (Paper No. 53—A-121)

1.5 Per Cent Carbon Cast-Steel Railroad-Car Wheels, by *N. A. Matthews* and *R. A. Flinn*, American Brake Shoe Co. (Paper No. 53—A-118)

The Use of Steel Wheels in Freight Service, by *B. C. Gunnell*, Southern Railway (Paper No. 53—A-119)

2:30 p.m.

Power (VII-A)—Applied Mechanics (IX)—Metals Engineering (V)—High-Temperature Steam Generation (II)—Effect of Temperature on Metals (II)—Heat Transfer (VIII)—Safety (II)—Petroleum (IV)

Piping-Flexibility Analysis, by *A. R. C. Markl*, Tube Turns, Inc. (Paper No. 53—A-51)

Elastic Constants and Coefficients of Thermal Expansion of Piping Materials Proposed for 1954 Code for Pressure Piping, by *Rudolph Michel*, Bureau of Ships, Navy Department (Paper No. 53—A-52)

In-Plane Bending Properties of Welding Elbows, by *P. L. Vissat* and *A. J. DelBuono*, Taylor Forge & Pipe Works (Paper No. 53—A-70)

2:30 p.m.

American Rocket Society (IV-A)

Liquid Properties, Handling, and Analytical Procedures

Oxidant Pumps, by *W. J. Mizen* (ARS Paper No. 99—53)

An Analytical Procedure for Mixed Acid, by *J. Clark* (ARS Paper No. 119—53)

Experience With the Application of Hydrogen Peroxide for Production of Power, by *H. Walter* (ARS Paper No. 120—53)

2:30 p.m.

American Rocket Society (IV-B)

Combustion Studies

Study of the Combustion of Fuel Droplets Falling Through an Oxidizing Atmosphere, by *D. Charonia* and *H. Wood* (ARS Paper No. 121—53)

Further Combustion Studies in Rocket Motors, by *K. Berman* and *S. Cheney, Jr.* (ARS Paper No. 122—53)

Ignition and Combustion in a Laminar Mixing Zone, by *F. Marble* and *T. Adamson* (ARS Paper No. 123—53)

2:30 p.m.

Machine Design (IV)

Proportional Control of Rate-Type Servometers[1]

Performance Operator[1]

Dynamic Performance Evaluation of Feedback-Control Systems[1]

2:30 p.m.

Boiler Feedwater Studies (II)—Power (VII-B)

Action of Boiler Water on Steel—Attack by Bonded Oxygen[1]

Corrosion of Steel in Boilers—Attack by Dissolved Oxygen[1]

Experimental Boiler Studies of the Breakdown of Amines[1]

2:30 p.m.

Production Engineering (VI)—Management (X)—Education (III)

Training Men to Cut Costs[1]

Adapting Engineered Maintenance to Moderate-Sized Plants[1]

2:30 p.m.

Metal Processing (V-B)

Evaluation of Bandsaw Performance[1]

Machinability Research With J & L Tool Dynamometer on Titanium 150A[1]

6:00 p.m.

American Rocket Society Honors Dinner

Presiding: *F. C. Durant, 3rd*, ARS President

Speaker: Maj.-Gen. *Donald Putt*, Commander Air Research and Development Command, USAF

8:00 p.m.

Plastic Flow of Metals—Applied Mechanics (X-A)

Pressure Distribution in the Cold Rolling of Metals[1]

8:00 p.m.

Machine Design (V)

The Borg-Warner Ford-Mercury Automatic Transmission Control[1]

Design of Hydraulic Equipment For Heat Dissipation[1]

Contribution to Hydraulic Control: VI. New Valve Configurations for High-Performance Hydraulic and Pneumatic Systems[1]

8:00 p.m.

Effect of Temperature on Metals (III)—Power (VIII)

Results of Service-Test Program on Transition-Welds Between Austenitic and Ferritic Steel at the Philip Sporn and Twin Branch Plants[1]

Cyclic-Heating Test of Main-Steam Piping Materials and Welds at Sewasen Generating Station[1]

The Stress-Rupture Properties of Some Chromium-Nickel Stainless-Steel Weld Deposits[1]

12 Per Cent Chromium Alloys for 1000 to 1200 Deg F Operation[1]

Effect of Certain Elements on the Graphitization of Steel[1]

8:00 p.m.

Petroleum (V)

The Automatic Sampling of Hydrocarbons in Direct Proportion to the Flow[1]

Stresses in Cylindrical Pressure Vessels Partially Supported by Soil, by *Gabriel Horvay*, *R. T. Gray*, and *W. Boothe*, General Electric Co. (Paper No. 53—A-82)

8:00 p.m.

Metal Processing (VI)—Applied Mechanics (X-B)—Production Engineering (VII)

Analysis of the Stresses in a Cutting Edge[1]

An Experimental Study of Metal Extrusions Under Various Strains[1]

---

[1] See box on page 836.

[2] Presented by title only.

FRIDAY, DECEMBER 4

8:00 a.m.

Registration

9:30 a.m.

American Rocket Society (V)

Symposium on Space

9:30 a.m.

Textile (I)

The Use of Oscillographs and Similar Instruments in Analysis of Machinery Operations[1]

What Textile Machinery Needs Variable Speed Drives and Why[1]

9:30 a.m.

Materials Handling (VI)

Ascertaining Materials-Handling Costs[1]

The Possibility of Improving Military Operations Through Mechanized Handling in the Field[1]

9:30 a.m.

Lubrication (IV)—Machine Design (VI)—ASTM (III)—ASLE (I)

Observations on Some Factors Affecting Timken Data for EP Lubricants, by *A. J. DeArdo* and *E. M. Kipp.* (Paper No. 53—A–39)

On the Solution of the Reynolds Equation for Slider-Bearing Lubrication, VIII, The Optimum Slider Profile for Viscosity a Function of the Pressure, by *Edward Saibel,* Carnegie Institute of Technology (Paper No. 53—A–38)

9:30 a.m.

Process Industries (IV)

Transient Gas Flame Temperatures in a Spherical Bomb[1]

A Direct Method for Flame-Temperature Calculation—Partial Oxidation of Methane[1]

9:30 a.m.

Petroleum (VI)

Comparative High-Temperature Properties of British and American Steels[1]

A Critical Examination of Procedures Used in Britain and the United States to Determine Creep Stresses for the Design of Power Plant for Long Life at High Temperatures[1]

9:30 a.m.

High-Temperature Steam Generation (III)—Power (IX)—Effect of Temperature on Metals (IV)

Experimental Superheater for Steam at 2000 Psi 1250 F, by *F. Eberle* and *F. G. Ely,* The Babcock & Wilcox Co., and *J. A. Dillon* (Paper No. 53—A–90)

9:30 a.m.

Production Engineering (VIII)

Die Engineering[1]

9:30 a.m.

Metal Processing (VII)

On the Drilling of Metals[1]

The Shear Stress in Metal Cutting[1]

9:30 p.m.

Wood Industries (I)

Building Accuracy Into Small Mills[1]

Design of Saw Blades for Better Dimensional Control[1]

Log Quality in Relation to Waste at Small Sawmills[1]

Better Yields From Dimensional Control in Small Sawmill Operations[1]

12:15 p.m.

Wood Industries Luncheon

Presiding: *Norman Bye,* director of engineering, Henry Disston & Sons, Inc., Philadelphia, Pa.

Speaker: *Cyril Ainsworth,* technical director, American Standards Association, New York

12:15 p.m.

Petroleum Luncheon

Presiding: *E. N. Kemler,* University of Minnesota.

Speaker: *R. J. S. Pigott,* past-president ASME

12:15 p.m.

Textile Luncheon

Presiding: To be announced

Speaker: *Herman A. Dickert,* director of A. French Textile School, Georgia Institute of Technology

Subject: **New Trends in Textile Education**

2:30 p.m.

Textile (II)

Drive Requirements for Cotton Machinery[1]

Drive Requirements for Woolen-Yarn Preparatory Machinery[1]

2:30 p.m.

Lubrication (V)—Applied Mechanics (XII)—Machine Design (VII)—ASLE (II)

Applying Bearing Theory to the Analysis and Design of Pad-Type Bearings, Part 1, **Fixed Pad Bearings,** and Part 2, **Pivoted Pad Bearings,** by *John Boyd* and *A. A. Raimondi,* Westinghouse Electric Corp. (Paper No. 53—A–84)

The Influence of Surface Profile on the Loaded Capacity of Thrust Bearings With Centrally Pivoted Pads[1]

The Hydrodynamic Pocket-Thrust Bearing, by *D. F. Wilcock,* General Electric Co. (Paper No. 53—A–83)

2:30 p.m.

Process Industries (V)

Super Refrigeration[1]

Use of Sorbents for Drying Process Gas and Air[1]

2:30 p.m.

Metal Processing (VIII)

Predicting Cutter Life for Face-Milling Cast Iron[1]

The Mechanics of the Simple Shearing Process During Orthogonal Machining[1]

2:30 p.m.

Wood Industries (II)

Modern Co-Operative Sawmill Operation For High Yields[1]

Spark-Arrester Performance Studies[1]

Forest-Fire Insurance in the United States[1]

* * * *

Women's Program at Annual Meeting

SUNDAY, NOVEMBER 29

4:00 p.m. to 7:00 p.m.	Reception at Engineering Woman's Club, 4 Washington Square, North

MONDAY, NOVEMBER 30

9:00 a.m. to 10:00 a.m.	Registration and Coffee Hour, Hotel Statler
12:15 p.m.	President's Luncheon, Hotel Statler
4:00 p.m. to 7:00 p.m.	Tea Dance, Hotel Statler

TUESDAY, DECEMBER 1

11:00 a.m.	Welcome Wagon Tour
12:30 p.m.	Annual Luncheon and Fashion Show, Pierre Hotel
8:15 p.m.	Coffee and Entertainment, Hotel Statler

WEDNESDAY, DECEMBER 2

9:30 a.m. to 12:15 p.m.	Annual Meeting of Auxiliary
12:30 p.m.	Luncheon, Tavern-On-The-Green
7:00 p.m.	Banquet

THURSDAY, DECEMBER 3

10:30 a.m.	Navy Yard Tour and Luncheon at Officer's Club, Brooklyn Navy Yard

Program of The Society for Experimental Stress Analysis

WEDNESDAY, DECEMBER 2

10:00 a.m. SESA I

Words of Welcome on behalf of the Society for Experimental Stress Analysis: *W. Ramberg,* president

Recent Developments in X-ray Methods for Residual Stresses in Hardened Steels, by *E. I. Blount, T. L. Thourson,* and *A. L. Ellis,* International Harvester Co.

Conventional Wire Gage as a Stress Gage, *H. Lissner,* Wayne University, and *C. Perry,* Vickers Corp.

A Photoelastic Interferometer Suitable for Static and Dynamic Measurements, by *Daniel Post,* Naval Research Laboratory

Residual Stresses in a Strip in Terms of Curvature or Strain Changes During Electropolishing, by *D. O. Leeser* and *R. A. Daane,* Argonne National Laboratory

2:30 p.m. SESA II

Symposium on Fatigue Testing Methods

Automatic Control of Fatigue Equipment, by *Edward Benda,* General Motors Corp.

New Fatigue Testing Methods, by *A. J. Amsler,* Amsler & Co.

European Developments in Dynamic Testing, by *Klaus Federn,* Carl Schenck & Co.

THURSDAY, DECEMBER 3

9:30 a.m.

Applied Mechanics VIII—SESA III

Torsional Vibration of a Thin-Walled Tube With a Large Mass at the Tip, by *Hsu Lo,* Purdue University

The Experimental Measurement of Mechanical Impedance or Mobility, by *R. Plunkett,* General Electric Co. (Paper No. 53—A–45)

A Method for Determining the Internal Damping of Machine Members, by *A. W. Cochardt,* Westinghouse Research Laboratories (Paper No. 53—A–44)

12:45 p.m.

Society for Experimental Stress Analysis Luncheon

Followed by Business Meeting and William M. Murray Lecture

The Stress-Concentration Problem in the History of Strength of Materials, by *S. Timoshenko,* Stanford University, Palo Alto, Calif.

FRIDAY, DECEMBER 4

9:30 a.m.

SESA IV—Applied Mechanics XI

Electrical Analog Solution of Certain Nonlinear Problems in Vibration and Elastic Stability, by *F. R. Berry, Jr.,* University of California

Experimental Analysis of the Buckling of Cylindrical Shells Subjected to External Hydrostatic Pressure, by *Edward Wenk, Jr., R. C. Slankard,* and *W. A. Nash,* David Taylor Model Basin

The Use of Photometric Devices in the Solution of the General Three-Dimensional Photoelastic Problem, by *M. M. Frocht, David Landsberg,* and *Hui Pih,* Illinois Institute of Technology

2:30 p.m. SESA V

Symposium on Strength at Elevated Temperatures

Analysis of Basic Problems of High-Temperature Creep, by *J. E. Dorn,* University of California

Metallurgical Aspects of Strength at High Temperature, by *George V. Smith,* U. S. Steel Co.

Dynamic Stress Measurements in Turbines, by *A. Brunot,* General Electric Co.

Combined Effects of Creep, Fatigue, and Damping, by *B. J. Lazan,* University of Minnesota

[1] See box on page 836.
[2] Presented by title only.

IRD Frequency-Response Symposium to Feature 16 Papers by International-Authorities

THE Instruments and Regulators Division of The American Society of Mechanical Engineers will present a two-day symposium on Frequency-Response Analysis.

The Symposium will be held on December 1 and 2 at the Statler Hotel, New York, N. Y., as a part of the 1953 Annual Meeting of the Society. Featured will be a number of original papers on the practical and theoretical aspects of frequency-response analysis, presented by American and European authorities on this subject.

Frequency-response analysis, which is widely used in the design and analysis of electronic equipment and servomechanisms, is presently being applied to the study of dynamic systems of all types, including industrial process-control systems. A number of original theoretical papers by recognized international authorities will describe the present status of the linear and nonlinear theory; practical papers will present examples of recent successful applications of the techniques to specific problems. One paper will survey existing sine-wave generators of the low-frequency, pneumatic-output type required for testing processes and related systems. A second paper will discuss the historical development of frequency-response techniques and present a well-organized survey of the literature on this subject. The recommendations of the Dynamic Systems Committee of IRD regarding presentations of frequency-response data will also be presented at this symposium.

For further information on the Symposium, please contact Stephen P. Higgins, Jr., Secretary, ASME—IRD Frequency-Response Symposium, Minneapolis-Honeywell Regulator Company, Brown Instruments Division, Wayne and Windrim Avenues, Philadelphia, 44, Pa.

Ira A. Hunt, Jr., Is New Freeman Fellow

THE winner of the 1953 Freeman Fellowship has been announced by the Award Committee as Ira A. Hunt, Jr., Captain, Corps of Engineers, U. S. Army. Captain Hunt attended Vanderbilt University for two years. He received his BS degree from the U. S. Military Academy at West Point, from which School he was graduated in 1945 as a distinguished cadet. He then served three and a half years in Europe on various construction and troop assignments.

Returning to this country in 1949, Captain Hunt attended Massachusetts Institute of Technology where he received his MS degree in 1950. He was an instructor in thermodynamics and fluid mechanics at the U. S. Military Academy, and in 1952 was the exchange instructor to the U. S. Naval Academy at Annapolis.

Captain Hunt left August 25th for Europe, where he will carry on a program of study and research. His first stop will be a 40-day stay in Holland, where he will make a report on the recent storm damage to dikes and levees. He has particular interest in waves and wind tides, wind-velocity profiles, and wave run-up on protective works. He will spend the greater part of his time at Grenoble, France, where he will take a course at the University of Grenoble and do laboratory research at the famous Neypric Hydraulics Laboratory. He expects to visit most of the large European universities to make a survey of the methods of instruction and the laboratory equipment and procedures used in their hydraulic courses.

The Freeman Fund was established in 1924 by the late John R. Freeman, past-president and Hon. Mem. ASME, and past-president and Honorary Member of the American Society of Civil Engineers.

ASME Elects Two Fellows

THE American Society of Mechanical Engineers has honored two of its members by electing them to the grade of Fellow of the Society.

To be qualified as a nominee to the grade of Fellow one must be an engineer with acknowledged engineering attainment, 25 years of active practice in the profession of engineering or teaching of engineering in a school of accepted standing, and a member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or members of the Society to the Council, to be approved by Council.

The men whose outstanding contributions to their profession and to the Society were so honored are:

Stephen Dewey Moxley

STEPHEN D. MOXLEY is the executive vice-president and vice-president in charge of engineering and purchases of the American Cast Iron Pipe Company, Birmingham, Ala. He has been with the company since 1923. While a mechanical engineer with the company, he was engaged in the mechanical design of machinery for a new process for the manufacture of cast-iron pressure pipe. He also conceived the ideas for and designed a number of machines which are in wide use today in the production of cast-iron pressure pipe by the sand-spun process and others. He holds nine U. S. Patents. From 1926 to 1937, as chief engineer, he directed engineering for a totally new process for the manufacture of pipe. He had charge of the design and directed the construction of all the machinery involved in the process. During this period a new and larger plant was constructed extending the sand-spun process from 12-in-diam pipe, 16 ft long, through 48-in-diam pipe, 16 ft long.

The University of Alabama college of engineering, where he received BS and MS degrees in mechanical engineering, conferred on Mr. Moxley the ME degree for his original engineering in connection with the development and the practical applications of this process.

In 1937 Mr. Moxley became assistant to the vice-president as well as chief engineer. At this time a new static foundry was constructed and equipped which was capable of producing gray-iron and steel castings at the rate of 2000 tons a month. The successful production of heavy-wall steel tubing by the sand-spun process was accomplished during this period. Since 1946 Mr. Moxley has been a director of the company and a member of the board of management. Under his supervision the company constructed and equipped 55,000 sq ft of machining facilities. He is also chairman of the company's research and development committee for production development and better production methods. He is the author of several outstanding papers on dust control, centrifugal casting of steel, and vocational guidance.

Mr. Moxley has been active in affairs of the ASME since 1924 when he joined the Society as a junior member. He was chairman of the Birmingham Section, 1932–1933; vice-president, Region IV, 1950–1952. He has served on the National Sections Committee, 1943–1947 and the Executive Committee of the Metals Engineering Division, 1948–1953 and member of the General Committee on Education.

He has served as president of the Engineers' Club of Birmingham. His membership in other honorary and professional engineering societies includes: Tau Beta Pi, Pi Tau Sigma, Newcomen Society of England, American Foundrymen's Society, and board of directors of the Birmingham Ordnance Association. In civic affairs he has participated as a member of the City Planning Board; board of directors, Birmingham Chamber of Commerce, and chairman of its Industrial Water Committee; board of directors, Birmingham Boys' Club, 1946–1952; board of governors, Vestavia Country Club, and member of "The Club." He received a citation from the board of trustees, University of Alabama, for services rendered in 1951 in conjunction with the establishment of the Foundry Education Foundation School and building and equipping the Foundry Laboratory.

V. Weaver Smith

V. WEAVER SMITH, vice-president, The Lummus Company, New York, N. Y., is known for his development of equipment for the oil industry and for his work in the chemical-processing field. In 1917 he developed new processes for the manufacture of chemicals such as benzoic acid and benzaldehyde. Later he developed the processes and designed a plant for the manufacture of benzyl chloride and arsenious chloride. From 1926 to 1931 while with the Superheater Company, New York, he was responsible for the development of new uses for superheated steam, especially for the oil industry. He designed lightweight portable equipment for producing superheated steam which made its use possible in drilling oil wells. He also developed direct-fired tubular heaters for use in the petroleum-processing and refining industry.

In 1933 he developed for Lummus, lightweight furnace walls for oil heaters, steam boilers, and other oil-heating equipment. In 1936 Mr. Smith developed powerful and mobile high-pressure steam-producing boilers to supply the power required for the increasing depths of oil-well drilling. Much of the equipment

developed by Mr. Smith has become standard in the oil industry, with patents granted in this country and abroad. From 1939 to 1943, acting as project director for Lummus, he had charge of the design and construction of all structures, equipment, controls, and safety devices of plants producing ammonium picrate (Explosive D) built for the Government by Lummus. During the World War II period, Mr. Smith co-ordinated the engineering work of six large steam-generating plants. He is now in charge of the design and construction of petroleum-refining and chemical-processing plants for The Lummus Company. Mr. Smith is the author of papers on steam drilling. He has served the Society in the Petroleum Division.

People

GUSTAV EGLOFF, Mem. ASME, director of research for Universal Oil Products Company, Des Plaines, Ill., has been elected an honorary fellow of the Royal Society of Edinburgh (Scotland).

* * *

ADOLPH MEYER, Life Member, ASME, Calvin W. Rice Lecturer, and managing director, engineer in chief, Brown Boveri and Company, Baden, Switzerland, will be awarded the George R. Henderson Medal by The Franklin Institute of the State of Pennsylvania. The award will be presented at the annual Medal Day Ceremonies in Franklin Hall, Oct. 21, 1953. At the same time the recipients of other awards will be honored and they are: GEORGE R. HARRISON, dean of science, The Massachusetts Institute of Technology, will receive an Elliott Cresson Medal; ROBERT F. MEHL, director of the Metals Research Laboratories and professor of metallurgy at Carnegie Institute of Technology, will be awarded the Francis J. Clamer Medal; S. DONNALD STOOKEY and ROBERT H. DALTON, research chemists of the Corning Glass Works, will receive John Price Wetherill Medals; and CHESTER F. CARLSON, consulting patent attorney and physicist of Fairport, N. Y., has been chosen to be the Edward Longstreth Medalist.

* * *

W. B. SHANNON, Fellow ASME, had the honor of receiving one of the Foundation Insignia Awards in Technology (C.G.I.A.) conferred on him at the annual general meeting of the City and Guilds Institute of London, England, in recognition of practical skill, knowledge, and attainment in mechanical industries (engineering). This is a new award intended as a mark of distinction for those with a combination of sound practical training and fundamental scientific principles who have shown a capacity for leadership and administration.

* * *

FRANK D. NEWBURY, Mem. ASME, has been appointed as an Assistant Secretary of Defense for Applications Engineering. This area lies between the work of Assistant Secretaries for Research and Development and for Supply and Logistics. The appointment is in line with the reorganization of the Defense Department.

ASME Calendar of Coming Events

Oct. 5–7
ASME Fall Meeting, Hotel Sheraton, Rochester, N. Y.
(Final date for submitting papers was June 1, 1953)

Oct. 29–30
ASME Fuels Division and AIME Coal Division Joint Conference, Conrad Hilton Hotel, Chicago, Ill.
(Final date for submitting papers was June 1, 1953)

Nov. 29–Dec. 4
ASME Annual Meeting, Statler Hotel, New York, N. Y.
(Final date for submitting papers was July 1, 1953)

March 10–12, 1954
ASME International Meeting, Hotel Del Prado, Mexico City, D. F.
(Final date for submitting papers—Nov. 1, 1953)

June 14–17, 1954
ASME Oil and Gas Power Conference, Hotel Muehlebach, Kansas City, Mo.
(Final date for submitting papers—Feb. 1, 1954)

June 20–24, 1954
ASME Semi-Annual Meeting, William Penn Hotel, Pittsburgh, Pa.
(Final date for submitting papers—Feb. 1, 1954)

Sept. 8–10, 1954
ASME Fall Meeting, Hotel Schroeder, Milwaukee, Wis.
(Final date for submitting papers—May 1, 1954)

Sept. 13–24, 1954
ASME Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Commercial Museum and Convention Hall, Philadelphia, Pa.
(Final date for submitting papers—May 1, 1954)

Sept. 26–29, 1954
ASME Petroleum—Mechanical-Engineering Conference, Statler Hotel, Los Angeles, Calif.
(Final date for submitting papers—May 1, 1954)
(For Meetings of Other Societies, see page 852)

Traveling Atomic-Energy Shows Visited Fairs, Expositions

THE American Museum of Atomic Energy in Oak Ridge utilized two of its larger traveling atomic-energy shows—"Atoms for Peace" and "You and the Atom"—at fairs and expositions throughout the country this summer.

Transported in large truck-trailers, both shows contained 30 atomic-energy exhibits, the same number contained in the shows co-sponsored during the fall and spring by the National University Extension Association and the Oak Ridge Atomic Institute.

The "You and the Atom" show opened its summer season on May 20 in Riverview Park, Chicago, Ill., where it remained until August 8, after having been attended by more than 331,000 persons. It then was moved to the Illinois State Fair in Springfield, where it stayed from August 14 to August 23. On August 28, it went to Columbus at the Ohio State Fair for an 8-day showing.

"Atoms for Peace" then opened on August 24 in Kingsport, Tenn., at the Kingsport Fair, where it remained until August 29.

A smaller exhibition entitled "Meet the Atom," comprised of 15 exhibits selected from the "You and the Atom" exhibition, was shown in Oklahoma City at the Oklahoma State Fair, September 26–October 3, and is scheduled for showing at the Arkansas Livestock Show in Little Rock, October 5–10.

Starting Salaries Rising for Graduate Engineers

RESULTS of a recent survey conducted by The Cooper Union indicate that nearly one out of five of its June, 1953, graduates from the School of Engineering decided to continue studying in graduate institutions despite the lure of an easy job market and the unprecedented high level of salaries now being offered to graduate engineers.

The survey, conducted by H. F. Roemmele, Mem. ASME, industrial-relations officer, and dean of students, showed that the remainder of the graduates from the Day Session of the School of Engineering received starting salaries which averaged $360 per month, representing an increase of 11 per cent over last year's average.

Professor Roemmele said that the number of graduates from engineering schools would decrease during the next few years, and that this factor, coupled with a yearly shortage of approximately 30,000 engineers, has caused a tremendous demand for the services of the available graduates. As an indication of this demand, he pointed out that during the past year alone there had been an increase of more than 28 per cent in the number of personnel officers from engineering firms who visited The Cooper Union to interview graduating seniors.

In the Evening Session graduating group, all of whom were employed during their attendance at the School, Professor Roemmele found an average salary of $5712, an increase of 10 per cent over last year's average for a similar group. Several members of this class were earning as high as $8700 a year.

1954 ASME Mechanical Catalog Just Published

THE 1954 ASME MECHANICAL CATALOG is being distributed to ASME members. Housed in a new cover, designed for ease in recognition, the current volume contains 50,000 listings of more than 6000 products of 4500 manufacturers and 345 pages of charts, photographs, and detailed drawings to aid engineers in their specifying and buying functions.

Constant editorial scrutiny of listings, industry-inspired phraseology revisions, and a continuous flow of suggestions from ASME members, serve to make the volume invaluable to engineers engaged in twenty-one basic industries.

Another important feature of the volume is the 20-page descriptive listing of all ASME publications. Its inclusion affords users an opportunity to check their requirements for special ASME publications and for the latest standards and codes.

The President's Page

Unity in the Engineering Professions Through EJC and ECPD

WE hear much these days of the crying need for unity within the engineering professions. There are those who would bring about such unity through some sort of an omnibus society, or overriding professional organization. It seems to us that the unity achieved through intersociety co-operation is a much more real and effective one. The community of interest between all of the professional groups in the engineering field, regardless of their specialties, is a very real one. There should be ample opportunities for them to meet on common ground, and indeed there are already many, although these might well be expanded. Yet each group has other interests which are mutually divergent, or at least possess no common denominator. In the usual case, the engineer's first love is his specialty. An omnibus organization which achieves unity by being all things to all men will very likely wind up by being nothing in particular to any man.

Some of the agitation for a unified engineering organization comes from those who believe that the Founder Societies should take political positions in the controversial issues of the day, to the extent that such issues affect engineers. These hold that, in order to be effective politically, it is essential that all engineering groups join hands, because of the political force of sheer numbers. We dealt with this question at length in the August, 1953, President's Page, and shall not attempt to elaborate upon that discourse here, other than to repeat our thesis that political logrolling is strictly outside of the frame of reference of the ASME, and would be a very hazardous activity for our Society to indulge in.

There are, of course, borderline cases, but in the Engineers Joint Council and the Engineers' Council for Professional Development, the Founder Societies and others possess effective means of dealing with matters of general interest to all engineers. Each body handles intersociety activities, the differentiation between the two being that EJC deals primarily with extraprofessional affairs, while ECPD deals with those of intraprofessional nature.

These two councils are performing an increasingly effective job in representing the common interests of engineers at the national and international level and resolving questions of over-all policy affecting the development, prestige, and social status of engineers generally. It seems to us that, at the high-policy level, the way to achieve a more effective unity within the engineering professions is to improve and perfect the functioning of these two organizations, rather than to replace them with something else.

At the regional and sectional level—in brief, at the working level of engineers—the interchange of ideas providing the means for common action, when needed, can best be effected through intersociety forums. These may be national in scope, such, for example, as the meeting to be held in Cleveland this month of the AIEE Subcommittee Conference on Machine Tools. At the local level, a large degree of unity, in matters where unity is necessary or desirable, is already being achieved through local engineering societies, whose meetings are open to all members of the local sections of the various professional groups.

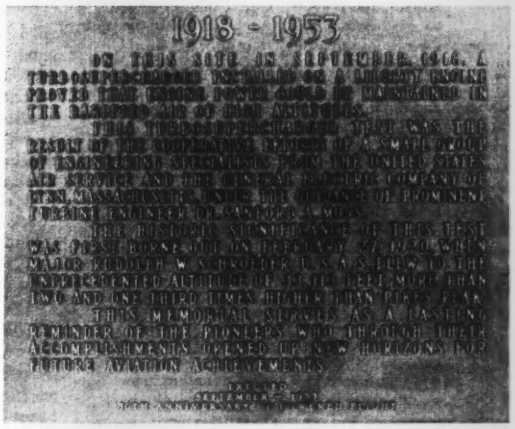
The late Thomas A. Edison was credited with the statement that a good rule for effective action is to "put all your eggs in one basket and then watch the basket." Obviously, there are areas in which engineers can be more effective when they pursue a unified course of action. However, we must avoid the danger of so scattering our fire that we lose the day-to-day driving interest of our membership. The manner in which the engineering professions are now organized into specialty groups, which, however, can still join in united action through EJC and ECPD, appears to us to be a happier solution to the problem of unity than any other which has yet been proposed.

FREDERICK S. BLACKALL, JR., *President*
The American Society of Mechanical Engineers

Fiftieth Anniversary of Powered Flight

Air Force Unveils Plaque, Aug. 26, 1953, on Pikes Peak Commemorating Scientific Achievements of Sanford A. Moss

Following the initial high-altitude test of the General Electric turbosupercharger in 1918 by Dr. Moss, renowned G.E. turbojet expert, the device was flight-tested for the first time in 1919 at McCook Field, Dayton, Ohio. Major R. W. Schroeder, the test pilot, *right*, with his observer, Lieut. G. W. Elsey, *center*, and Dr. Moss, *left*. Major Schroeder's daring flight to an altitude of 36,000 ft marked neither the beginning nor the end of the turbosupercharger's story. Twenty years following Schroeder's historic flight, RAF Boeing B-17s, equipped with later-model turbosuperchargers, dropped their bombs on the German submarine pens from above the French coast.



Three years after Dr. Moss and his Army Air Corps and G-E colleagues made their historic Pikes Peak test, a LePere Biplane equipped with the G-E turbosupercharger, piloted by Lieut. J. A. Macready, now a retired AF colonel, made a record altitude flight of 40,800 ft at Dayton, Ohio. Here before the record-breaking flight on Sept. 18, 1921, Lieut. Macready posed with his colleagues. *Left to right:* Lieut. Macready, Dr. Moss, Major G. E. A. Hallett, and Adolph "Doc" Berger. Mr. Berger was an Army Air Corps sergeant during the Pikes Peak test and later became known as "Mr. Turbosupercharger" at Wright Field.

The late Dr. Moss is pictured here in his office at the G-E plant, Lynn, Mass., in 1941. In 1940 the Collier Aviation Trophy was presented jointly to Dr. Moss and the Army Air Corps for the development of the turbosupercharger. This development increased the extent of modern high-altitude, long-range flying. The General Electric Company's success in turbosupercharger and gear-driven supercharger and turbine development led to its selection as the first American producer of a jet engine.

Successful tests atop Pikes Peak conducted by the late Dr. Moss in 1918 resulted in the development of the General Electric turbosupercharger hailed today as one of the outstanding contributions to aviation. Dr. Moss and Gen. James H. Doolittle are pictured here inspecting a later model of the turbosupercharger during an air show in Schenectady, N.Y. in 1946. Research on the turbosupercharger reached a climax in 1939 when an early model B-17 Flying Fortress, equipped with four G-E turbosuperchargers, flew coast to coast in nine hours and 14 minutes.

Professional Engineering Registration and the Young Engineer

A Statement Prepared for the ASME Committee on Engineers Registration

By H. L. Solberg[1]

THE first law regulating the registration of professional engineers was adopted by he state of Wyoming in 1907. The movement spread slowly until the decade following the end of World War I; between 1918 and 1930, over half of the states adopted registration laws. At the present time, laws governing the practice of professional engineering are in effect in each of the 48 states, the District of Columbia, and the territories of Alaska, Puerto Rico, and Hawaii. Approximately 160,000 engineers are currently licensed to practice professional engineering under these laws.

It should be clearly understood that registration of engineers is not primarily for the benefit of engineers, but rather to safeguard life, health, and property and to promote the public welfare by limiting the practice of professional engineering to those who can meet the minimum standards as set forth in the laws of the several states. Thus the basic purpose of licensing engineers is the protection of the public against incompetent practice.

The question is often asked as to who must be registered to comply with the requirements of the law. Since laws vary between states, representatives of the major engineering societies have prepared a "Model Law," the latest edition of which has been endorsed by 13 of the major engineering societies. The "Model Law" is used as the basis for legislation in most states and contains the following definition of the practice of engineering:

"The term 'Practice of Engineering' within the meaning and intent of this Act shall mean any professional service or creative work requiring engineering education, training, and experience and application of special knowledge of the mathematical, physical, and engineering sciences to such professional services or creative work as consultation, investigation, evaluation, planning, design, and supervision of construction for the purpose of assuring compliance with specifications and design, in connection with any public or private utilities, structures, buildings, machines, equipment, processes, works, or projects . . ."

An engineer who performs any of the various acts covered by the foregoing definition of the practice of engineering must be licensed as a professional engineer provided that (1) such acts affect life, health, and property or the public welfare, (2) the individual is responsible for the final decisions, and (3) is not exempt under some of the special exemption clauses that are written into the laws of some states.

Qualifications

A person who is a graduate of an accredited engineering curriculum must have a minimum of four years of practical engineering experience of such a character as to satisfy the State Registration Board that he is qualified to be placed in responsible charge of engineering work. In general, experience gained prior to graduation is heavily discounted because, for obvious reasons, it cannot be at the professional level of the work done by the engineering-college graduate. Also, routine and repetitive activities which do not develop the individual during the period following graduation will be heavily discounted. Consequently the college graduate should be sure that the experience he is obtaining is at a level which is developing and maturing his engineering abilities if he expects to be registered as a professional engineer within 4 or 5 years following graduation.

Examinations

The graduate of an accredited engineering curriculum who is of good moral character and can meet the experience requirements outlined in the preceding paragraph may be registered in some states upon verification of his record. However, more than two thirds of all licensed engineers are now registered in states which require a written or written and oral examination of not less than two days' duration as one of the qualifications for registration. This practice is spreading and it is reasonable to expect that most of the students now enrolled in engineering colleges will be required to pass such an examination.

The Engineer-in-Training Program

Within the past ten years, many states have adopted an engineer-in-training program under which the engineering-college graduate may take a one-day written examination covering engineering fundamentals at about the time of graduation. Generally these examinations are conducted by the State Registration Boards on the campuses of approved engineering schools. The candidate who successfully passes this examination is given an engineer-in-training certificate which will exempt him from the first day of the two-day written examination in the state in which it is issued when he applies for registration as a professional engineer in that state. In general, other states having reasonably equivalent standards, will also recognize his engineer-in-training certificate. Since most engineering-college students will ultimately be required to pass a two-day written examination as a requirement for registration and since most ambitious young engineers aspire to a position of responsibility which probably will require registration, the majority of engineering college graduates in many states are now taking the engineer-in-training examination.

Procedure for Registration

The tenth amendment to the Constitution specifically reserves to the several states the police powers under which professional licensing is regulated. This results in nonuniform standards but these differences are being reduced. Also, it gives the registrant the right to practice professional engineering (or medicine or law) only in the states in which he is registered. Consequently a person desiring to be licensed should apply to the Registration Board of the state in which he is employed for advice concerning requirements and application forms.

Reciprocity

In general, a registered professional engineer can obtain reciprocal registration in another state upon submission of satisfactory evidence that he has been registered in a state having qualifications substantially equivalent to those in effect in the state in which he is applying for registration. It is for this reason that it is advantageous for the young engineer to be registered in a state having high standards including a two-day written examination.

[1] Head, School of Mechanical Engineering, Purdue University, and Member, Indiana State Board of Registration for Professional Engineers and Land Surveyors. Fellow ASME.

ASME Membership as of August 31, 1953

Honorary Members	53
Fellows	380
Members	13,778
Associates	337
Juniors (33 and over)	3,370
Juniors (30-32)	1,998
Juniors (to the age of 29)	18,099
Total	38,015

Twelve Regional Student-Branch Conferences End Successful 1952–1953 Season

MORE than fourteen-hundred student members of The American Society of Mechanical Engineers, representing most of the 135 student branches of the Society, attended the 12 regional conferences held all over the country during March, April, and May of this year. Over 100 of the country's leading colleges and universities were represented.

A great deal of interest and enthusiasm was generated at this year's conferences by reports of student chairmen on the operation and activities of their respective student branches and discussions of how they handled various problems confronting them. The conferences thus provided a platform for exchanging ideas on the best ways of making student-branch meetings more interesting, building attendance at meetings, and keeping student members interested in student-branch activities. Ways of recruiting more lower classmen into student branches was a much discussed subject. Solutions to the problem of sustaining member interest in meetings reported were: holding meetings to short sessions, showing movies, going on field trips, and having committees do most of the work in organizing meetings. The need for good professional speakers at meetings was particularly stressed. Other subjects that came up for discussion included the low percentage of student transfers to junior membership, improvement of student conferences, prizes awarded at conferences, and methods of scoring and judging papers.

Student Papers High in Quality

Student papers presented at the conferences were generally of a high caliber, well written, and well presented. A rich variety of engineering subject matter was represented in the papers. Competition for prizes was keen and the judges had difficulty in some cases in deciding winners of the awards. There was a heavy attendance at the technical sessions indicating the keen interest of the students in the conferences. Success of the conferences was due in great part to the hosts whose skill in organizing and running the programs insured smooth and well-run technical sessions. Besides the opportunity of hearing student speakers, the students heard interesting and challenging talks by eminent engineering educators, industrial leaders, and top ASME officers. Field trips to engineering laboratories, industrial plants, and campus tours were liberally arranged for the students. Prizes were generally awarded at banquets and luncheons along with mileage trophies of various types.

A high light of the Region II conference, held at The College of the City of New York, was the luncheon at which Willie Ley, noted rocket authority, spoke on "Our Atmosphere." One-hundred people attended the luncheon. A farcical lecture and demonstration performed by a student pretending to be a fictitious Dr. Sigmund Hopf of Berlin University, was thoroughly enjoyed. The next conference will be held at Polytechnic Institute of Brooklyn.

Sixteen papers were presented at the Region III conference at Princeton University. Second prize at this conference went to a midshipman from the U. S. Naval Academy. A tour of engineering laboratories, an engineers' dance, and a banquet were features at this conference. The 1954 conference is scheduled for the University of Rochester. Next year a Man-Miles Plaque will be awarded to the school which has the highest record of "man-miles."

At the Region IV student conference, North Carolina State College received first prize for having the greatest number of students in attendance and also the Man-Miles Plaque for the most man-miles traveled. Host school for this conference was the University of Florida. This conference was held in conjunction with the Region IV Regional Administrative Committee Meeting of the ASME. Next year's host will be the University of Tennessee in Knoxville.

The conference which attracted the largest number of students was the Region V conference at The Ohio State University. Almost 200 students from 13 colleges and universities were present. This conference overlapped by one day the ASME Spring Meeting and the students were thus able to attend the President's Luncheon and hear F. S. Blackall, jr., President and Fellow of ASME, speak. His subject was "For A Stronger and More Dynamic Society." Prizes were awarded by Mr. Blackall at this luncheon. Another feature of the Region V conference was a luncheon and inspection trip, courtesy of the Denison Engineering Company of Columbus. W. C. Denison, president of the company, addressed the students on the value of human relations in industry. Wayne University will be host at the next conference.

Region VI Holds Two Conferences

The Region VI Northern Tier conference was held at Iowa State College. Students at this conference were guests at a banquet at which E. T. Neubauer of the Trane Company, La Crosse, Wis., spoke on "A Fundamental Theory of Hydrogen Embrittlement." A campus tour was arranged for the students who saw the Ames Laboratory, Atomic Energy Commission; electron microscope; the low-temperature laboratory, air liquefaction; and the WOI-TV telecasting studios. The next conference will be held at the University of North Dakota.

Winner of the Region VI Southern Tier competition was a State University of Iowa student who wrote on the subject "A Solution of the Cedar Rapids, Iowa, Traffic Problem." Eleven papers were presented at this conference, which was held at Washington University. In addition to an inspection trip to the McDonnell Aircraft Corporation, students heard Fred Roever of this company speak on "How Does a Mechanical Engineer Fit Into the Aeronautical Field?" The University of Louisville will be host next year.

Over 180 students were present at the Region VII Pacific Northwest student conference held at the University of Washington. Total number of man-miles traveled was 74,200. A luncheon and a banquet were high lights of this conference. Speaker at the banquet was G. S. Schaller of the mechanical-engineering department of Washington University, who addressed the students on the subject, "Pioneers or Settlers." Some interesting field trips were arranged through the Aircraft Carrier *Essex*, and the Bethlehem-Pacific Coast Steel Corporation. Next year's conference will be held in Canada at the University of British Columbia.

The Region VII Pacific Southwest conference was held at the University of Utah. The conference was opened by a talk by A. Ray Olpin, president of the University, who linked the mechanical engineer with the progress that has been made in the world during the past 50 years, together with possible progress in atomic power in the next 10 years. Students at this conference also attended a banquet at which Dan McLachlan, Jr., professor of metallurgical engineering and physics of the University, spoke on "Mechanical Engineering and the Food Supply." Next year's conference was tentatively set for the University of Arizona.

Region VIII Holds Three Meetings

The University of Nebraska was host at the Region VIII Northern Tier conference. Students at the University conceived and constructed a man-miles trophy which was won by the University of Arkansas. Four inspection trips, an annual banquet, and an awards luncheon were enjoyed by students at this conference. At the Honors Convocation students were addressed by Dr. Ben M. Cherrington, regional director of the Institute of International Education of Denver, Colo., on "The Role of Research and Scholarship in the Preservation and Extension of Freedom." Next year the student conference will be held in conjunction with the annual meeting of Region VIII in Tulsa, Okla. The Mid-Continent Section will be host.

The Region VIII Southern Tier conference was held concurrently with the Fourth Annual Meeting of Region VIII in New Orleans. Tulane University was the host college. Students at this conference had the opportunity of attending technical sessions, luncheons, and banquets of the senior meeting in addition to their own sessions. At this conference students heard Prof. J. C. Morriss, vice-president, Tulane University, speak on "Leonardo da Vinci, the First Mechanical Engineer." The conference next year will be at Louisiana Polytechnic Institute.

One of the high lights of the Region VIII Rocky Mountain Tier conference held on the Colorado A&M College campus, was a banquet at Ladd's Covered Wagon. At this banquet there were addresses by Clifford H. Shumaker, vice-president, Region VIII, and professor of management engineering at Southern Methodist University, and Harold Grasse of Black and Veatch, consulting engineers, Kansas City, Mo. The next conference is scheduled for the University of Colorado.

1953 ASME Regional Student Conference Prize Winners

REGION I, NEW ENGLAND, UNIVERSITY OF NEW HAMPSHIRE, DURHAM, N. H., APRIL 24-25, 1953

REGION II, EASTERN, COLLEGE OF THE CITY OF NEW YORK, NEW YORK, N. Y., APRIL 18, 1953

Attendance: 124 Papers Presented 7

Prize	*Recipient*	*Title of Paper*	*College*
First	James Ten-Broeck Baker	Opportunities for Mechanical Engineers in the Petroleum Industry in the Middle East.	Pratt Institute
Second	Robert Blum	The Problem of Machine Intelligence.	Polytechnic Institute of Brooklyn
Third	William S. Cameron	Air Pollution.	Polytechnic Institute of Brooklyn Evening School
Fourth	Christopher E. Nugent	Gear Hobbing.	Newark College of Engineering
Old Guard	Robert B. Morgan	Better Utilization of Steam Motive Power.	New York University
Sixth	William L. Dugan	Refining of Used Oil.	Stevens Institute of Technology
Seventh	Saul Fenster	The Importance of Collective Bargaining to the Engineer and to the Community.	College of the City of New York

REGION III, ALLEGHENIES, PRINCETON UNIVERSITY, PRINCETON, N. J., APRIL 17-18, 1953

Attendance: 113 Papers Presented: 16

Prize	*Recipient*	*Title of Paper*	*College*
First	Robert F. Conti	An Investigation of a Method for Pumping a Corrosive Molten Metal.	Cornell University
Second	William G. Kirk	The Stationary Flame Front Engine.	U. S. Naval Academy Midshipman School
Third	Clement C. Hipkins	Possibilities of Acoustical Reactance Damping in an Automotive-Exhaust System.	Catholic University of America
Fourth	Gerald W. White	An Analysis of Power-Steering Mechanisms.	Pennsylvania State College
Old Guard	Theodore S. Moise	Increasing the Output of Internal-Combustion Engines.	Johns Hopkins University

REGION IV, SOUTHERN, UNIVERSITY OF FLORIDA, GAINESVILLE, FLA., APRIL 8, 1953

Attendance: 118 Papers Presented: 13

Prize	*Recipient*	*Title of Paper*	*College*
First	D. E. Blackwood	Gas-Turbine Locomotives.	University of Alabama
Second	Marcus B. Crotts	The Principles of Operation of the Most Common Types of Coal Pulverizers.	North Carolina State College
Third	Charles E. Shufelt	Ramjet-Shell Design.	Duke University
Fourth	R. H. Miller	Automatic Transmission, Truck, and Automobile.	Virginia Polytechnic Institute
Old Guard	Elmer C. Kaylor	Unionmelt Welding of Boiler Drums.	University of Tennessee
Sixth (Slide Rule)	Daniel M. Carmichael	Tests on the Cutting Action of Circular Saw Teeth.	Clemson College

REGION V, MIDWEST, OHIO STATE UNIVERSITY, COLUMBUS, OHIO, APRIL 27-28, 1953

Attendance: 197 Papers Presented: 11

Prize	*Recipient*	*Title of Paper*	*College*
First	George R. Criswell	Tubeless Tires.	University of Akron
Second	Leonard Spontelli	Jet Engines for Aircraft.	Fenn College
Third	Thomas R. Willsie	The Effect of Load Factor on Vehicle Fuel Economy.	University of Toronto
Fourth	William L. Dollenmayer	Bearing-Bracket Design for Overhung Impellers on Single-Stage Centrifugal Pumps.	Carnegie Inst. of Technology
Old Guard	Louis Povinelli	Operating Principles of Liquid Motors.	University of Detroit

REGION VI, NORTHERN TIER, IOWA STATE COLLEGE, AMES, IOWA, MAY 4-5, 1953

Attendance: 53 Papers Presented: 10

Prize	*Recipient*	*Title of Paper*	*College*
First	Robert Herzberg	Cast Iron That Bends.	Marquette University
Second	Allan P. Geddes	Economic Possibilities of Gas-Driven Heat Pump.	South Dakota School of Mines
Third	Howard Kern	Rocket Development and Potentialities.	Illinois Institute of Technology
Fourth	Jerome E. Greuel	The Heat's On.	Northwestern University
Old Guard	Joseph J. Fields	Wrecker Design.	Iowa State College

REGION VI, SOUTHERN TIER, WASHINGTON UNIVERSITY, ST. LOUIS, MO., APRIL 23-24, 1953

Attendance: 128 Papers Presented: 11

Prize	*Recipient*	*Title of Paper*	*College*
First	Lloyd Keyser	A Solution of the Cedar Rapids, Iowa, Traffic Problem.	State University of Iowa
Second	A. V. Stutz	Bullett Velocity Determination by Metal Displacement.	University of Louisville
Third	Marvin W. Boyd	Vacuum-Power Brakes.	Missouri School of Mines and Metallurgy
Fourth	Richard Grimm	Simulation of Aerodynamic Compressible-Flow Phenomena by the Hydraulic Analogy	Washington University
Old Guard	Perry M. Perkinson	The Use of Liquid Petroleum Gas as a Fuel for Internal-Combustion Engines	University of Kentucky

REGION VII, PACIFIC NORTHWEST, UNIVERSITY OF WASHINGTON, SEATTLE, WASH., APRIL 30–MAY 2, 1953

Attendance: 182 Papers Presented: 10

Prize	Recipient	Title of Paper	College
First	Donald H. West	The Properties of Ductile Iron When Welded to Steel.	Oregon State College
Second	Charles P. Costello	Geared Turbine Versus Turboelectric Drive for Cargo-Ship Propulsion.	University of Washington
Third	Tyman Fikse	An Automatic Brake Adjuster.	University of Washington
Fourth	Lawrence L. Bockhold	Surface Finish Applied to Punches and Dies.	University of British Columbia
Old Guard	Herman E. Schnidrig	A Study of Gasketless Pipe-Flange Joints.	State College of Washington

REGION VII, PACIFIC SOUTHWEST, UNIVERSITY OF UTAH, SALT LAKE CITY, UTAH, MAY 14–16, 1953

Attendance: 92 Papers Presented: 5

Prize	Recipient	Title of Paper	College
First	Victor Kebely	Combustion Stability in Ramjets.	University of California
Second	Clayton Williams	Thermal Properties of Type-C Gilsulate.	University of Utah
Third	Kelly Thurston	Conversion of an L-Head Engine to an F-Head and the Comparative Performance.	University of Utah
Fourth	Leon C. Michaelson	Hydraulic Oil-Well Pumping.	California Institute of Technology
Old Guard	Gerald H. Ross	Design Problems of a Gamma-Ray Spectometer.	California Institute of Technology

REGION VIII, NORTHERN TIER, UNIVERSITY OF NEBRASKA, LINCOLN, NEB., APRIL 20–21, 1953

Attendance: 105 Papers Presented: 12

Prize	Recipient	Title of Paper	College
First	Alan Zimmerman	Perimeter Heating.	Kansas State College
Second	Albert S. McDaniel	Shell Molding.	University of Arkansas
Third	Joseph E. Beshoory	The International Engineer.	University of Oklahoma
Fourth	Warren Beevers	The Water-Table Analogy.	Kansas State College
Old Guard	Richard R. Hudson	Counterbalancing of Beam Pumping Units.	Oklahoma A&M College

REGION VIII, SOUTHERN TIER, TULANE UNIVERSITY OF LOUISIANA, NEW ORLEANS, LA., APRIL 14, 1953

Attendance: 142 Papers Presented: 8

Prize	Recipient	Title of Paper	College
First	Calvin L. Barker	Rocket Motor.	University of Texas
Second	I. Merritt Singer	Fundamentals of Safety-Valve Design.	Rice Institute
Third	Robert N. Kennedy	Engineering Aspects of Atomic Radiation.	Southern Methodist University
Fourth	Ernest A. Prochaska	Free-Piston Engine.	Texas A&M College
Old Guard	Martin L. Huber	Lubrication Practice for Passenger-Car Engines.	Tulane University of Louisiana

REGION VIII, ROCKY MOUNTAIN TIER, COLORADO A&M COLLEGE, FORT COLLINS, COLO., APRIL 24–25, 1953

Attendance: 141 Papers Presented: 13

Prize	Recipient	Title of Paper	College
First	Samuel Galetar	Pioneering of a Bottling Body for Retail Delivery	University of Colorado
Second	Dwight S. Taylor	High-Strength Ceramics	University of Denver
Third	John L. Mudd	Let's Put Some Management in Engineers.	University of Wyoming
Fourth	Leon E. Garrison	Production of Liquid Nitrogen.	University of Colorado
Old Guard	Francis D. Manzolillo	Inertia in the Engineering Profession.	Colorado A&M College

(For other Regional Student Awards see page 850)

George Westinghouse Professorship Established at Penn State

THE Educational Foundation of the Westinghouse Electric Corporation recently undertook to sponsor a George Westinghouse Professorship in Engineering Education at the school of engineering of The Pennsylvania State College. Intended to organize and develop an effective program of "teaching engineering teachers to teach," this grant will enable the school of engineering to subsidize:

1 A scientific analysis of engineering educational methods and techniques.

2 A re-evaluation of educational standards and objectives.

3 A modern, up-to-date program of scientific instruction.

With a critical shortage of engineers in all fields, with the broadening of science, and the resulting need for educational consolidation, the new program of engineering education, under the direction of Eric A. Walker, dean of the engineering school, will engage a scientist to "bring engineering knowledge to a common denominator of understanding."

"The average engineering teacher," Dean Walker maintains, "knows little or nothing about the theories of teaching. He has never studied the learning process nor has he carefully considered how he can transfer understanding effectively from textbook to student. Preparing himself either with advanced scientific degrees or by working in industry, he extends, by the first approach, his knowledge of physical science and, by the second, learns how to work as a member of a team as well as gaining administrative experience. Yet, neither of these courses teaches him to teach. In fact, being carried further from the level of abstraction he attained as a student, he recognizes less clearly the difficulties students have in understanding engineering principles.

"Similarly," Dean Walker continues, "the engineering student, though taught to think in the shorthand of equations, a limited but peculiarly precise manner of thinking, is equally ignorant of the basic concepts of engineering. Exposed to the individual teaching methods of various teachers and to the barrage of formulas, theorems, and equations, too often memorized without being understood, he cannot codify the isolated studies of his education. He has come to confuse facts with knowledge and, despite his training in inductive versus deductive reasoning, he can-

Prizes, Other Than Those for Papers Presented at Student Conferences

1 Two prizes of $25 and $15 were awarded at each Conference to the Student Branches, other than the host college, having the largest and next largest percentage of Student Members attending.

2 A Certificate was presented at each Conference to the Student Branch having the largest percentage of potential Student Membership in the third through sixth years among Student Branches participating.

3 Each Conference was encouraged to develop a sentimental trophy to recognize the largest number of man-miles traveled to the Conference. If trophies were presented, the winners are mentioned below.

Region	*$25 Prize*	*$15 Prize*	*Potential Student Membership Certificate*	*Man-Miles Trophy*
I				
II	Newark College of Engineering	Polytechnic Inst. of Brooklyn	Newark College of Engineering	
III	Catholic University of America	Villanova College	Swarthmore College	University of Rochester
IV	North Carolina State College	Vanderbilt University	Virginia Poly. Institute	North Carolina State College
V	University of Dayton	University of Detroit	University of Dayton	University of Detroit
VI Northern	South Dakota State College	South Dakota School of Mines	University of North Dakota and South Dakota State College	
VI Southern	Rose Polytechnic Institute	Bradley University	Rose Polytechnic Institute	Rose Polytechnic Institute
VII Pacific Northwest	State College of Washington	Oregon State College	University of British Columbia	State College of Washington
VII Pacific Southwest	California Inst. of Technology	University of Santa Clara	University of Arizona	California Inst. of Technology
VIII Northern Tier	University of Arkansas and Kansas State College, Tied		University of Arkansas	University of Arkansas
VIII Southern Tier	Louisiana Poly. Institute	Texas Technological College	University of Texas	Texas Technological College
VIII Rocky Mountain Tier	University of Denver	University of Wyoming	Colorado A&M College	

not inductively determine the scientific bedrock upon which his engineering education rests and his livelihood depends.

"Living in an engineering age," the Dean declares, "we must take the kinks out of engineering education. By simplifying and correlating our technical studies in all fields of engineering and centralizing our instruction about the basic sciences, we can accelerate our engineer's education, systematize his thinking, and graduate more and better-trained engineers to fill the vacancies in government and industry.

"Assuming this challenge," Dean Walker predicts, "though our results may be some time in coming, Penn State's experiment in engineering education is expected to revitalize scientific instruction and, perhaps, to develop some basic methods of education itself."

Best Utilization of Scarce Engineering Talent to Be Discussed

THE annual three-day meeting of the Engineers' Council for Professional Development to be held jointly with the American Society for Engineering Education in the Statler Hotel, New York, N. Y., Oct. 14 through 17, will be highlighted during the Friday afternoon session on the 16th when a special panel sponsored by the Engineering Manpower Commission will discuss "Engineering Manpower Utilization." Case histories of better utilization methods will be the theme of this special session at which tried and proved techniques will be brought out.

In announcing this session, T. A. Marshall, Jr., Mem. ASME, executive secretary of EMC, said that prominent industrial executives who have dealt directly with this problem would reveal a pattern for improving utilization based upon their own experience. "Throughout the session," Mr. Marshall said, "emphasis will be placed on the details of practical methods that have been used to effect better utilization for the benefit, not only of their industrial employers but also for their own professional development."

T. H. Chilton, chairman of the Engineering Manpower Commission, will be official chairman of the session.

H. N. Muller, Jr., who is assistant to the engineering vice-president of the Westinghouse Electric Corporation, Pittsburgh, Pa., will present a paper based on a pattern used at Westinghouse to achieve better engineering utilization.

Chester L. Brisley, industrial engineering manager, Wolverine Tube Division of Calumet and Hecla, Inc., will present a demonstration of the work-sampling study method of increasing the professional content of engineers' work.

The author and general content of a third paper now in preparation will be announced at an early date.

This meeting will be one of the first of its kind to be devoted entirely to the working details aimed at improving the utilization of scarce engineering talent. As such, it promises to be of great importance to industrial interests employing engineers, inasmuch as tried and proved ways and means of effecting more efficient use of engineering staffs will be revealed.

600 Industrialists, Educators, and Scientists Attend Corrosion Meetings at Wrightsville Beach

OVER 600 engineers, executives, and educators from all branches of industry, marine science, and government attended a series of three meetings at the International Nickel Company's "Kure Beach" Corrosion Testing Station near Wilmington, N. C., during the week of September 13. The meetings included technical conferences at nearby Wrightsville Beach.

At the first session, Inco acted as host to the Electrochemical Society at its 104th meeting beginning on Monday, Sept. 14, and ending on Wednesday, Sept. 16. The annual meeting of the Sea Horse Institute was held Wednesday evening and continued through Friday. An appropriate portion of the Institute sessions was devoted to the special interests of the Marine Borer Conference.

The Corrosion Division of the Electrochemical Society gave two special symposiums: one on marine corrosion and the other on titanium corrosion. The Electrodeposition Division of the Society dealt with electrodeposition problems in general, while the Battery and Electrothermic Divisions held roundtable discussions on various current topics. A feature of the Electrochemical meeting was the Palladium Medal Lecture delivered by Nathaniel Howell Furman of Princeton University. The Palladium Medal for outstanding contributions in the fields of corrosion and funda-

mental electrochemistry was presented to Dr. Furman at the Society's banquet on Tuesday evening at the Ocean Terrace Hotel. F. L. LaQue, in charge of Inco's Corrosion Engineering Section, was general chairman of the meeting.

At the annual Sea Horse Institute meeting, Mr. LaQue led discussions at five sessions held at the Crest Theatre Wednesday through Friday. Some of the topics discussed were the use of cathodic protection, protective coatings and decorative finishes, and corrosion of salt-water pumps. Presentation of the William F. Clapp Memorial Award for outstanding contributions to the knowledge of marine biology was made to C. H. Edmonson, Bishop Museum, University of Hawaii, at the Crest Theatre, on Friday, September 18.

The Marine Borer Conferences, on Thursday and Friday at the Crest Theatre, consisted of round-table discussions dealing with the life processes of marine borers, preservation of structural materials, and engineering practices. Discussions were led by F. L. LaQue and A. P. Richards, of William F. Clapp Laboratories, Inc., Duxbury, Mass.

Representatives of over 200 leading industrial concerns and government agencies from 35 states and three foreign countries, as well as 20 leading engineering colleges and universities, were present at various meetings.

Machine-Tools Conference Sponsored by AIEE

THE Sixth Annual Conference on Machine Tools sponsored by the Subcommittee on Machine Tools of the American Institute of Electrical Engineers will be held at the Cleveland Hotel, Cleveland, Ohio, Oct. 14–16, 1953.

A series of 11 technical papers will be presented on a wide variety of subjects from "the application of calculating machines to the control of machine tools to today's machine tools need modern electrical codes."

The technical program provides the engineers with up-to-date information on new products, processes, and techniques. They will have an opportunity also to discuss their applications and mutual problems in connection with various standards, codes, and safety regulations applicable to the designing, building, and use of electrified machines.

This conference is an activity of the subcommittee to promote its purpose of "Achieving greater productivity and safety of machine tools through electrification, for the purpose of raising the standard of living and aiding the common defense."

Plant tours are scheduled also this year to Ford Motor Company, Engine Plant; Warner & Swasey Company; Reliance Electric & Engineering Company; and Chevrolet Motor Company, Transmission Plant.

The Banquet on October 14 will be addressed by Frederick S. Blackall, jr., president of Taft-Peirce Manufacturing Company and President of The American Society of Mechanical Engineers. His subject will be "The Engineer's Obligation to a Free Society."

L. B. Seltzer, editor of the Cleveland Press, will be the guest speaker at the informal luncheon on Oct. 15.

The past 15 years has seen a revolution in the electrification of machine tools. The circuit design has become so complex that the electrical controls and motors can no longer be considered as an addition to the machine, but must be designed as an integral part of the machine.

Registration Begins for International Management Congress to Be Held in São Paulo

REGISTRATION of the U. S. Delegation to the Tenth International Management Congress to be held early next year in São Paulo, Brazil, Feb. 19–24, 1954, officially began the end of August with the acceptance of the first registration, that of Dr. Lillian M. Gilbreth, Hon. Mem. ASME, and prominent management consultant, according to an announcement by the Council for International Progress in Management.

This Brazilian industrial city, fastest growing metropolis in the world, will serve as an excellent backdrop for the international management session and, at the time of the Congress, will be celebrating its 400th anniversary.

Top-level business-executive groups, representative of the 20 free nations, will make up a virtual management boiling pot from which is expected to result the first real postwar contributions to better management the world over.

The American delegation to the Congress, whose personnel will be composed of several hundred business administrators, management specialists, and educators, will have as its theme the title of the American paper to be presented, "Top Management's Responsibility Toward Modern Managerial Technique." Other papers will be presented by various countries: Belgium—Management Methods of Improving Human Relations; The Netherlands—Policy Determination, Direction, and Control of Marketing; Switzerland—Controls for Top-Management Use; Italy—Executive Training and Development; Sweden—Developing an Effective and Co-Operative Organization Structure; France—Policy Making as Effected Outside the Control of Management, Particularly Those Related to Credit and Taxation; and Great Britain—Application of Modern Management Techniques to the Smaller Enterprise.

Separate subcommittees of the American group, working with business leaders here, have begun preparing five sections of the

SÃO PAULO, BRAZIL, WHERE THE TENTH INTERNATIONAL MANAGEMENT CONGRESS WILL BE HELD ON FEBRUARY 19–24, 1954

(Ave. São Joao looking toward the 36-story São Paulo Bank Building, Brazil's tallest skyscraper.)

American paper, on modern managerial techniques, benefits of such techniques, and problems of selection, application, and evaluation.

The responsibilities of management are changing rapidly both in character and in dimensions, according to A. M. Lederer, president of CIPM and partner in the management consulting firm of Morris and Van Wormer. He stated that greater pressures are put on those who mold the direct policies of industry as compared with those imposed on their predecessors, with the forces coming not only from within a plant but from worldwide technological and social shifts.

He pointed out that the American paper, in drawing on all types of companies, will put the responsibility for material and human progress squarely where it belongs—on top management.

The Brazilian Management Council, official host to the Congress, is making special arrangements for intensive study of Brazilian industry, of which São Paulo is a major center.

Leading Hydraulic Engineers From Eighteen Countries Attend Minnesota International Hydraulics Convention

THE Minnesota International Hydraulics Convention, which combined the fifth plenary meeting of the International Association for Hydraulic Research and the second separate meeting of the Hydraulics Division of the American Society of Civil Engineers, introduced several innovations in meetings of this character. It was held at the University of Minnesota in Minneapolis Sept. 1–4, 1953, with many eminent scientists and engineers from 18 countries throughout the world in attendance, as well as delegates from 35 states of the United States and the District of Columbia. Preceding the convention by one day, there was also in session a Hydrology Meeting of the North Central Regional Branch of the American Geophysical Union.

A particularly unique feature of the convention was the prepublication of all technical papers in a monumental volume, elaborately illustrated by 550 diagrams, charts, and photographs, containing some 570 8½ × 11 size pages incorporating 49 comprehensive hydraulics papers by 75 authors from some 20 countries. The preprinting of the Technical Proceedings proved to be exceptionally effective in scheduling the technical sessions and stimulating discussion.

The theme of the Congress was directed toward four geophysical aspects of hydraulics as follows: (*a*) Basic relationships of sediment transportation by flowing water; (*b*) density currents; (*c*) air entrainment by flowing water; and (*d*) waves, beach erosion, and the hydromechanics of shore structures. Countries participating for the first time since World War II in these sessions included Yugoslavia and Japan. A half-day tour was made through the St. Anthony Falls Hydraulic Laboratory, displayed in full operation.

At the opening sessions Theodore C. Blegen, dean of the Graduate School of the University of Minnesota, made the welcoming address and stressed the importance of freedom of thinking and international co-operation in all research work, whether fundamental or applied. E. C. Stakman, the world-renowned plant pathologist, addressed this session on a topic phrased, "Land and Water—May They Get Together Better." He discussed the unbalance in the international sphere of the world's increasing population and the distribution of land for agricultural needs. Emphasis was placed on further development of water resources for irrigation, recognizing the diverse needs of either increase or decrease in water on various lands to enhance their utility, and the development of plant types which will require less water than many types now in prevalent use. The speaker at the concluding luncheon meeting of the convention was Major General S. D. Sturgis, Jr., Chief of Engineers of the U. S. Army, who discussed "Water Resource Development."

The International Association for Hydraulic Research selected Delft, The Netherlands, for its next plenary meeting to be held in September, 1955. A new Constitution was also adopted by the IAHR. The officers elected at the concluding session were: president, Lorenz G. Straub, Minneapolis, Minn., U. S. A.; vice-presidents: M. Pierre Danel, Grenoble, France; Shri A. N. Khosla, New Delhi, India; and G. de Marchi, Milan, Italy; secretary, Prof. J. Th. Thijsse, Delft, The Netherlands. Members elected to the Association's governing Council, along with the officers, are Sir Claude Inglis, Wallingford, England; Bo Hellstrom, Stockholm, Sweden; M. Bayer, Brno, Czechoslovakia; Arthur Ippen, Cambridge, Mass., U. S. A.; L. Tison, Gand, Belgium; Koichi Aki, Tokyo, Japan; and Ali Mohsin, Karachi, Pakistan.

The volume of Technical Proceedings which includes all papers in complete illustrated form is now being sold at $6 plus 75 cents mailing charge a copy and may be had immediately by prepayment to secretary, Minnesota International Hydraulics Convention, St. Anthony Falls Hydraulic Laboratory, Minneapolis 14, Minn., U. S. A. The volume can be purchased outside the United States by payment with UNESCO dollars.

Centennial of Engineering Symposium Volume Announced

WHEN the Centennial of Engineering drew to a close it was apparent that the past hundred years had witnessed a story of progress out of all proportion to the preceding centuries. The contents of this volume prove this," wrote Charles F. Kettering, Hon. Mem. ASME, in the foreword to the 1080-page book recently released by Lenox R. Lohr, president, Centennial of Engineering, 1952, Inc.

The first 116 pages contain the story of how the centennial idea took form in 1948 when ASCE past-president Malcolm Pirnie was appointed chairman of the ASCE Centennial Planning Committee; the theme and philosophy of the ten-day celebration held in Chicago, Ill; the addresses made at the Awards Luncheon on Sept. 10, 1952, considered by many to be the high light of the Centennial; Mr. Kettering's address, "A Review of the Century" at the Centennial Evening Party; and the script of the play "Adam to Atom."

There follows the complete printed record of the symposium papers and discussions presented during the Convocation period, Sept. 3 to 13, 1952, covering practically every phase of engineering. The 12 over-all symposium subjects were selected for their broad influence on the day-to-day lives of our people, and their social, economic, and political bearing on the advancement of civilization. These papers dramatize the developments of the past one-hundred years and the highly significant part played by engineering in developing the United States to its present position of world leadership. The subjects of the 12 symposiums are: The Role of the Organized Professions; Education and Training; Food; Tools; Transportation; Mineral Industries; Structures and Construction; Chemical Industries; Communication; Energy; Health and Human Engineering; and Urbanization.

Most engineers will wish to own this history and coverage of the Centennial of Engineering, 1852–1952. It is available at $10 postpaid either from Lenox R. Lohr, Museum of Science and Industry, Chicago, Ill., or from William N. Carey, Executive Secretary, American Society of Civil Engineers, 33 West 39th Street, New York 18, N. Y.

Meetings of Other Societies

Oct. 8–9
Gray Iron Founders' Society, 25th silver anniversary meeting, Hotel Jefferson, St. Louis, Mo.

Oct. 12–14
American Management Association, office management conference, Hotel Astor, New York, N. Y.

Oct. 15–17
ISO/TC 63, screw threads for glass containers, London, England

Oct. 16–18
Society of Industrial Designers, annual design conference, Bedford Springs, Pa.

Oct. 19–21
American Standards Association, 35th annual meeting, Waldorf-Astoria Hotel, New York, N. Y.

Oct. 19–21
American Institute of Mining and Metallurgical Engineers, annual fall meeting of the Petroleum Branch, Adolphus and Baker Hotels, Dallas, Texas

Oct. 19–23
National Safety Council, 41st national safety congress and exposition, Conrad Hilton, Congress, Morrison, and Hamilton Hotels, Chicago, Ill.

Oct. 19–23
American Welding Society, 33rd annual meeting, Hotel Cleveland, Cleveland, Ohio

Oct. 19–23
American Society of Civil Engineers, annual convention, Statler Hotel, New York, N. Y.

(*Continued on page 853*)

Oct. 19–23
American Society for Metals, national metal congress and exposition, Statler Hotel, Cleveland, Ohio

Oct. 24–27
ISO/TC 29, small tools, Paris, France

Oct. 28–30
American Society of Body Engineers, seventh annual technical convention, Rackham Memorial Building, Detroit, Mich.

Oct. 28–31
ISO/TC 10/SC 1, drawings, Paris, France

Oct. 29–30
Society of Automotive Engineers, international production meeting, Royal York Hotel, Toronto, Ont., Can.

Oct. 29–31
National Council of State Boards of Engineering Examiners, 32nd annual meeting, the Plaza Hotel, San Antonio, Texas

Oct. 30–31
Society for the Advancement of Management annual fall conference, Statler Hotel, New York, N. Y.

Nov. 2–6
ISO/TC 27, solid mineral fuels, London, England

Nov. 2–6
Society of Automotive Engineers, national transportation, diesel engine, and fuels and lubricants meetings, Conrad Hilton Hotel, Chicago, Ill.

Nov. 2–6
American Institute of Electrical Engineers, fall general meeting, Hotel Muehlebach, Kansas City, Mo.

Nov. 5–6
Mellon Institute of Industrial Research, eleventh annual Pittsburgh diffraction conference, Mellon Institute, Pittsburgh, Pa.

Nov 6–10
ISO/TC 3/SC 1, limits and fits, Paris, France

Nov. 9–11
National Academy of Sciences, autumn meeting, Massachusetts Institute of Technology, Cambridge, Mass.

Nov. 9–12
American Petroleum Institute, 33rd annual meeting, Conrad Hilton Hotel and Palmer House, Chicago, Ill.

Nov. 12–13
Society of Naval Architects and Marine Engineers, 61st annual meeting, Waldorf-Astoria Hotel, New York, N. Y.

(ASME Calender of Coming Events, see page 843)

ISCC Cautions Users of Unscientific Corrosion Preventives

THE Inter-Society Corrosion Committee, which is sponsored by the National Association of Corrosion Engineers, has become greatly concerned about the hazards which may result from dependence on certain unproved devices for controlling corrosion and scaling. The Committee recommends that caution be exercised in the application of such devices, since any failure to give protection may result in serious damage to expensive equipment where a real problem of corrosion or scaling exists.

The Inter-Society Corrosion Committee is made up of about 35 delegates from major technical societies, in the United States and Canada, actively concerned with problems of corrosion control and with the scientific reduction of the economic loss caused by corrosion. By means of this word of caution, and in accordance with its established objectives, the Committee seeks to promote the use of the many scientifically sound and effective devices and processes which are available at present and to discourage dependence on unsound and ineffective methods of control.

The Committee wishes to draw particular notice to devices which are not based on any understandable scientific principle and which are generally promoted on the basis of testimonials unsupported by quantitative data, from presumably satisfied customers. Special attention is drawn to supposedly scientific explanations which make liberal and incoherent use of such terms as catalysis, magnetism, electronics, radiation, etc. Such "explanations" do not appear to have any basis in scientific fact.

In some cases recommendations are made by manufacturers that grounding wires of electrical circuits, if unfavorably connected to pipes in which the devices are installed, should be rearranged or connected elsewhere. The Committee emphasizes that if, after one of these devices has been installed, the electrical circuits are not grounded in accordance with the National Electrical Code, serious impairment of the safety of persons and property may result.

Against this background, and in line with its responsibilities, the Committee then recommends extreme caution in the application of devices for control of corrosion and scaling that are characterized by operation without any apparent basis of sound scientific principles and for which no adequate engineering performance data are available.

Twentieth Century Fund Committee Reports on Collective Bargaining

FREE collective bargaining has proved itself a flexible and effective method of setting wage rates for American workers, but the parties concerned should give more attention to the possible effects of their action on the economic system as a whole, says a special Committee of the Twentieth Century Fund, including business leaders, labor officials, and economists, in a new report, "Employment and Wages in the United States," issued by the Fund. Members of the nine-man Committee put forward a wide range of opinions, as to the general policies that might be followed by labor and management in setting wage rates fair to the worker, to the employer, and to the country as a whole.

Among recommendations of the Committee were the following: No set of mechanical rules, based on rigid standards of wage determination, should be substituted for negotiations and compromise of conflicting pressures and interests in our wage-setting process; free collective bargaining has proved itself as a wage-setting process, but it should be improved to reflect more accurately the interests of all parties concerned, including consumers, and to reduce friction, conflict, and interruption of production; management can improve employment conditions by hiring on merit, assigning employees to jobs for which they are best fitted, and increasing the security of job tenure and the regularity of employment; unions should provide members with better information on job opportunities, eliminate race and sex discrimination in membership, and work with management to get workers into expanding industries and out of declining ones; and if government does its part in preventing inflation, we might expect unions, as a general rule, to accept raises approximating the probable rate of increase of output per man-hour *for the economy as a whole*.

The recommendation that particular wage increases should be set to keep pace with the general rise in productivity, that is, the increase in the average output per man-hour for the economy as a whole, was considered of limited value by some members of the Committee, who pointed to the difficulty of establishing the productivity figure, the complexity of our present wage structure with many rates below prevailing levels and others above, and the impossibility of adjusting fairly other types of income—pensions, rents, and so on—to match the wage "formula."

Others held that the increment of gain from increased productivity over long periods should not go all to labor, but should be shared with the public in the form of improved products or lower prices and with the investor who supplies the facilities for production.

Some held that increases in productivity generally *follow* increases in wages, as higher wage rates force management to look for ways of reducing costs, making it profitable to invest in new machinery or improved processes.

Continuation of the rate of increase in real wages, either in individual industries or by communities, or for the country as a whole, will impose no great strain upon employers in maintaining or reducing real labor costs per unit of output. If normal good judgment is used, and extreme wage fluctuations avoided, the effect on prices can be safely ignored.

With full employment the bargaining power of labor will be strong enough generally to keep money wage rates rising a little ahead of increases in output per man-hour, so that prices will tend to rise slowly.

The report further revealed that it is important for those who play an important role in wage determination to take these criteria seriously. Trends in productivity, ability to pay, cost of living, etc., are stubborn forces that affect real wages, employment opportunity, standards of living, and the functioning of our economy.

"The worker should have such protection, but the level established should be capable of 'retreat' as well as 'advance,' to maintain the flexibility necessary to meet inflation and deflation alike.

"Raising of the substandard wages that still prevail in many areas should be one of the prime objectives of national wage policy. Employers should give more effort to 'fitting the job to the worker,' rather than trying to make the worker fit into the job.

Mid-Century Conference on Resources for the Future

WITH the appointment of an over-all steering committee and the selection of eight major areas for discussion, the structure of the Mid-Century Conference on Resources for the Future—a nationwide forum scheduled in Washington, D. C., December 2 to 4—is nearing final form.

The Mid-Century Conference has been called by Resources for the Future, Inc., a nonprofit corporation for research and education in the field of natural resources. The agency has received a grant from the Ford Foundation for conducting the conference.

Norvell W. Page, conference director, announced that Conference chairman Lewis W. Douglas has appointed 16 persons to a steering committee on which the many elements actively concerned with natural resources are represented. Plans call for adding one or two more members to the committee in the near future.

Included are representatives of the industries that extract, trade in, and use raw materials, along with representatives of conservation organizations and groups interested in long-range problems bearing on resources.

The conference steering committee members selected and their broad range of interests represented underline the special importance of the forthcoming resources conference. "Since the conservation movement was launched under Theodore Roosevelt a half century ago," R. G. Gustavson, president, Resources for the Future, said, "there have been many separate studies and meetings of industrial and conservation groups. Now it is proposed, for the first time on so large a scale, to bring them together in a single meeting to look at the resources problem as a whole and to endeavor, through study and discussion, to point the way to mutually satisfactory solutions."

Conference Will Not Endorse Programs

The conference, Dr. Gustavson added, will not endorse programs or seek to come forward with a program of its own. Rather, he said, "the great contribution of this mid-century meeting can be to lay the groundwork for the adoption by others, in both public and private undertakings, of policies and programs which will safeguard and promote the national interest now and for later generations."

Industry groups are co-operating in the preparation of background material as aids to conference discussion. In addition, recent reports on the resources position of the United States such as those of the Paley Commission, the Cooke Commission, and some reports of the Hoover Commission will be among the documents considered by the conference as background material.

Eight Major Topics to Guide Discussion

Indications of the number expected to accept invitations to the conference suggest that attendance will be too large to permit easy discussions by the entire membership. Therefore, in addition to general sessions, the conference will be divided into eight sections in which most of the conference work will be done. Section sessions will run concurrently.

On the decision of the conference chairman and steering committee, the eight sections will be centered around the following main areas: Section 1, Competing Demands for Use of Land; Section 2, Utilization of Land Resources; Section 3, Water-Resource Problems; Section 4, Problems of Nonfuel Minerals; Section 5, Energy-Resource Problems; Section 6, World Supply and Availability; Section 7, Problems in Resources Research; Section 8, Patterns of Co-Operation.

Each section will have a chairman and co-chairman. These officers, with the aid of a section steering committee, will meet in advance to identify and state the main issues for discussion in each of the sections.

Actions of the ASME Executive Committee

At a Meeting at Headquarters, July 29, 1953

A MEETING of the Executive Committee of the Council was held in the rooms of the Society on July 29, 1953. F. S. Blackall, jr., chairman, presided. In addition to Mr. Blackall, there were present: H. E. Martin, A. C. Pasini, and W. F. Thompson of the Committee; J. L. Kopf, treasurer; E. J. Kates, assistant treasurer; C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary.

New Subsection

On the recommendation of Vice-President S. H. Graf, and with the approval of the San Francisco Section, the Committee voted to authorize the establishment of a Sacramento Subsection.

Disbandment of Section

The disbandment of the Peninsula Section, Region V, was authorized to become effective 60 days after a date to be determined by Vice-President E. S. Theiss.

Student Membership Cards

The secretary was authorized to arrange with the honorary chairman of each Student Branch to issue a Student Membership card to each Student Member as he pays his dues, setting up the necessary controls in the Secretary's office.

Publications Policy

At the meeting of the Council in Los Angeles, the recommendations of the Publications Committee were considered briefly by the Council before their review by the Board on Technology. As early action is imperative, the Executive Committee reconsidered these recommendations and authorized the Secretary to distribute to each member with his bill for dues for 1953–1954, ten coupons which can be used to secure preprints of papers.

1953 Regional Delegates Conference

Three recommendations of the Regional Delegates Conference were submitted to the Executive Committee for consideration. Two of these items dealt with unity in the profession. Mr. Kates was requested to formulate wording of specific recommendations for consideration by the Committee at the Rochester meeting.

The third item requested a special report of Council action on RDC agenda items within one month after action has been taken. This request was approved, the approval to be embodied in the final tabulation of Council actions on RDC recommendations.

Certificates of Award

Certificate of Award was granted to Louis E. Carter, retiring chairman of the Baltimore Section.

Certificate of Award was also granted to Robert J. Cramer, Jr., retiring member of the Executive Committee of the Oil and Gas Power Division, and chairman, 1951–1952.

National Bureau of Standards

The President reported that the National Bureau of Standards has announced a curtailment in the calibration and testing services of the Bureau to the public because of limitation in funds.

The Committee adopted the following statement of position on the action of the Bureau of Standards:

"The American Society of Mechanical Engineers, toward the end of the nineteenth century, made strong representation to the Congress to establish the National Bureau of Standards to safeguard basic standards of measure and act as an impartial arbiter on questions of fact relating to these basic standards of measure.

"A communication dated July 17, 1953, from the Director of the Bureau of Standards announces a curtailment of these basic services.

"The Council of this Society has reviewed the communication of the Director and has restated its early position that the operation of complicated mechanical industry demands an impartial government arbiter of questions of fact about standards of measurement. Any relaxation of this function will result in confusion in American mass manufacture. This service function is well worth its cost, whatever it is, and the fees should be set so that costs of fact determinations by the Bureau are paid by those who need these services."

Policy Set For Future Society Meetings

A REVISED policy for future Society meetings was approved at the ASME Executive Committee of Council meeting held in New York on July 29. Established by the Meetings Committee of the Society, this policy concerns the location and dates of national meetings, Division conferences, and meetings of other national societies co-sponsored by ASME.

The revised policy is as follows:

1 The Annual Meeting of the Society will be held in New York, N. Y., except every

fourth year, when it may be moved on invitation from a Section having a membership in excess of 2000 and serving over 20,000 members within a radius of 500 miles.

2 The Semi-Annual Meeting of the Society will be held in the Great Lakes industrial area on invitation from a Section having a membership in excess of 500 and serving over 10,000 members within a radius of 500 miles, except every fourth year, when it may be moved to the Pacific coast on invitation from a Section meeting the above conditions or having a membership in excess of 1000 without regard to the membership served within a radius of 500 miles.

3 The Spring and Fall Meetings of the Society will be held alternately in the Northern, Southern, Eastern, and Western areas of the country on invitation from a Section having a membership in excess of 200. Exceptions with respect to the membership requirements may be made by the Meetings Committee if the combined membership of several Sections working together exceeds 200. Other exceptions may be made by the Meetings Committee when deemed to be in the best interests of the Society.

4 In establishing location and dates for National Meetings of the Society, every effort will be made to avoid conflicts with established dates of Division Conferences and meetings of other national societies. An approved list of such major national societies will be prepared and a similar reciprocal agreement requested from them.

5 Requests for Division Conferences shall be submitted to the Meetings Committee for approval of location and dates in order to give full effect to item 4 above.

6 The Committee recognizes the need and advantages of Regional Meetings as authorized by the Council on an experimental basis. The scheduling of Regional Meetings should be co-ordinated with other meetings to avoid conflict in dates with other meetings of the Society.

7 Programs for the Annual and Semi-Annual Meetings of the Society will be sent to all members; programs for the Spring and Fall Meetings of the Society will be sent only to all members in the Region containing the host section and to all other members residing within 500 miles of the host section.

8 Requests for ASME co-sponsorship of meetings of other national societies shall be submitted with recommendations to the Meetings Committee for approval.

Coming Meetings

Safety

THE annual National Safety Congress and Exposition will be held in Chicago, Ill., Oct. 19–23. More than 12,000 persons from all over the world will hear 600 program participants at 200 sessions discuss all aspects of accident prevention.

Safety personnel in all fields—industrial, traffic, farm, school, and home—will find new information and techniques aimed at their specific problems. In the industrial field alone, 25 complete programs conducted by the industrial sections of the National Safety Council will include automotive and aircraft manufacture, metals, printing, petroleum, mining, food, construction, public utilities, wood products, and many others.

In addition, the American Society of Safety Engineers will sponsor sessions of general interest to men in all industries. Some of the topics will be nuclear energy, electronic testing, psychology of safety, machine guarding and protective equipment, research on safety, and safety training.

Paul J. Mundie, well-known industrial psychologist, will give a series of four "early morning" sessions designed to increase the safety-man's personal effectiveness. These lectures dealing with the human factors in the accident problem will provide information on developing intellectual effectiveness, emotional maturity, and the art of handling others.

The 1953 exposition will feature the largest and most comprehensive display of accident-prevention equipment to be seen anywhere. All exhibit space in the Conrad Hilton hotel will be filled with products, equipment, and services relating to the promotion of safety, health, first aid, sanitation, and general welfare.

Noise Abatement

THE fourth annual National Noise Abatement Symposium will be held October 23 and 24 at Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill.

The symposium, designed to give a comprehensive picture of nationwide activities in the field of noise, will feature talks by leading authorities on outdoor-noise problems. One session will be devoted to the industrial-noise hazard.

Although the three previous meetings were one-day affairs, this year's symposium has a broader scope and will extend over a two-day period. Eleven speakers will fill out the agenda for the two morning and one afternoon sessions.

Transport Aircraft Hydraulic Conference

VICKERS, Inc., will sponsor the third Transport Aircraft Hydraulic Conference. It will be held at the Park Shelton Hotel, Detroit, Mich., Nov. 3-4, 1953.

The program will cover transport aircraft hydraulic systems in general, including accessories, tubing, fittings, and hydraulic fluids. Enough operating time will have been accumulated on new Convair 340's and Lockheed 1049's to permit representative discussion of the new hydraulic-system features of those aircraft.

Education

Cathodic Protection

CATHODIC Protection will be the subject of a three-day corrosion short course to be given at the University of California at Los Angeles, Calif., Nov. 16–18, 1953. Registration will be limited to 110 persons. It will be directed toward training maintenance and operating personnel in installation and maintenance of cathodic-protection systems in the field.

Sessions will last six hours daily and will include the following topics: Basic electrochemical principles, corrosion circuit theory, corrosion engineering, instruments and measuring techniques, design and application of cathodic protection, and economics of cathodic protection. Meetings will be held at 813 S. Hill Street, Los Angeles.

The short course will be followed by the Western Region Division Conference of National Association of Corrosion Engineers to be held at the Biltmore Hotel in Los Angeles, Nov. 19–20, 1953.

* * *

University of Texas engineers are designing new supersonic wind-tunnel equipment to simulate take-off conditions for high-speed aircraft. The equipment will allow scientists to determine in detail just how jet and rocket engines operate as an aircraft makes its take-off climb.

* * *

Construction of Yale University's new underground atomic laboratory has been completed and a 20-million-volt linear accelerator is scheduled to begin operation late this summer. H. L. Schultz and W. G. Wadey, associate and assistant professors of physics, are supervising installation of the new atom-blasting equipment.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after Oct. 24, 1953, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member

NEW APPLICATIONS

For Member, Associate, or Junior

ACKMANN, LOWELL E., Peoria, Ill.
AHMED, KAMALUDDIN, Shillong, Assam, India
ANSPACH, HERMAN F., Lebanon, Pa.
BAKER, MERL, Lexington, Ky.
BARIM, ISIK M., Bursa, Turkey
BEEMAN, WARD E., Saginaw, Mich.
BELLAMY, DAVID A., Montreal, P. Q., Can.
BIGONY, PAUL E., Orange, Texas
BLASDALE, RICHARD H., New Bedford, Mass.
BONFIGLIO, JOSEPH R., Roseville, Mich.
BONI, RAYMOND L., Philadelphia, Pa.
BORMANN, CONRAD B. Hicksville, N. Y.
BRIDWELL, ROBERT A., Lynwood, Calif.
CARRARO, EUGENE J., Schenectady, N. Y.
CHEVINS, EDWARD J., New York, N. Y.
CHRISTEN, JOSEPH E., New York, N. Y.
CIEPIERSKI, CASIMIR J., Staten Island, N. Y.
COMPTON, WILLIAM A. Cleveland, Ohio
DAWSON, ROBERT H., Chicago, Ill.
DEGENARO, RALPH P., Staten Island, N. Y.
DEITZ, WILLIAM, Baltimore, Md.
DEWEY, SYDNEY L., Canton, Ohio
DYER, GEORGE G., Cleveland, Ohio
ECCLES, FRANK M., Schenectady, N. Y.
ELLENBERGER, EDWARD G., Baltimore, Md.
FAUCETT, THOMAS R., Rochester, N. Y.
FEAGAN, JACK R., Amarillo, Texas

FILAORO, JAMES, Mounds, Ill.
FORREST, ROBERT P., JR., El Paso, Texas
GARDNER, JOHN R., Opportunity, Wash.
GIBBONS, JOHN P., Indianapolis, Ind.
GOTT, ALLAN H., Corning, W. Va.
GREEN, FORD F., New York, N. Y.
GURE, CHARLES P., Worcester, Mass.
HAERTEL, ALFONS A. B. F., Lancaster, Pa.
HALPINE, PAUL A., Pittsburgh, Pa.
HANNA, RICHARD E., Tulsa, Okla.
HEINZE, FREDERICK J., Drexel Hill, Pa.
HESS, ROBERT G., Redwood City, Calif.
HICKS, BEATRICE A., Bloomfield, N. J.
HOLCOMB, JOHN E., Spokane, Wash.
HOLMES, WILFRED J., Honolulu, Hawaii
JOHNSON, HENRY F., Allendale, N. J.
LANDIS, DICK M., Hyde Park, N. Y.
LEHREN, ROBERT J., Greensburg, Pa.
LICHON, LEO L., Saginaw, Mich.
LINDBERG, E. LELAND, Lincoln, Neb.
LINDER, DAVID W., La Mesa, Calif.
LORBER, HAROLD, Brooklyn, N. Y.
LUNDQUIST, DANIEL, Jamestown, N. Y.
MACHEN, JAMES S., Littleton, Colo.
MACINNES, JAMES C., Springfield, Pa.
MARCELLINO, FRANK J., Havertown, Pa.
MAXWELL, JOSEPH R., Elsmere, Del.
MCCARTY, JOHN O., Atlanta, Ga.
MCCUNE, FRANCIS K., Niskayuna, N. Y.
MCCUTCHAN, JOSEPH W., Encino, Calif.
MILLER, QUINCY N., New Orleans, La.
MOCEY, WALTER G., Philadelphia, Pa.
NICHOLSON, JAY T., Glendale, Calif.
NIGRO, LOUIS A., St. Albans, N. Y.
OEHRING, MARVIN P., Saginaw, Mich.
OSSWALD, ROBERT F., Schenectady, N. Y.
RAMIREZ, ARTHUR R., Baton Rouge, La.
ROWLEY, JOHN C., Ann Arbor, Mich.
RUSKIN, SEYMOUR M., Lombard, Ill.
SHAFER, GUY C., JR., Cincinnati, Ohio
SHAW, JOHN R., Wickliffe, Ohio
SLEDGE, GUY P., JR., Freeport, Texas
SMITH, WILLIAM R., Oak Ridge, Tenn.
SOEHNGEN, KURT A., Los Angeles, Calif.
SPROAT, JOHN R., Charleston, W. Va.
STEPHEN, RALPH C., Monterey Park, Calif.
SUPP, ROBERT E., Indianapolis, Ind.
TAYLOR, WILLIAM H., Jacksonville, Fla.
WINKLER, ROBERT L., Baltimore, Md.
ZERBE, WILLIAM E., Honolulu, Hawaii

CHANGE IN GRADING

Transfers to Members and Associate

ANDERSON, MARSHALL, Schenectady, N. Y.
ANDREINI, JOSEPH I., Massapequa, N. Y.
BLAKESLEE, THEODORE R. 2nd, Easton, Pa.
BROOKS, ROBERT D., Pittsburgh, Pa.
DEL MAR, WALTER H., Pacific Palisades, Calif.
FULLER, FORNEY, New Orleans, La.
HOWE, FRED J., Pensacola, Fla.
KATTELMANN, HARRY R., Oakland, Calif.
KEZIOS, STOTHE P., Chicago, Ill.
LELAND, SAMUEL C., Boston, Mass.
LIZARDOS, GEORGE J., Flushing, N. Y.
MEYER, CHARLES A., Drexel Hill, Pa.
MONTGOMERY, FRANCIS R., Honolulu, Hawaii
MYATT, DONALD J., Alexandria, Va.
NORDGREN, HARRY C., JR., Toledo, Ohio
OPKINS, JEROLD S., E. Meadow, L. I., N. Y.
RAGUSAN, JAMES J., Brooklyn, N. Y.
SPENCER, ALFRED C., JR., Maplewood, N. J.
STIVERS FRANK O., Houston, Texas
THOMAS, WARREN M., Bartlesville, Okla.
TRIBBLE, JOSEPH J., Savannah, Ga.
WHITEHEAD, ROBERT C., JR., Oreland, Pa.
WYKOFF, WALTER R., Los Alamos, N. Mex.

Transfers from Student Member to Junior 50

4

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th Street	84 East Randolph Street	100 Farnsworth Ave.	57 Post Street

Men Available[1]

Mechanical Engineer, 16 years' experience in design, development, and production of special machines for machine-tool, textile industry. Proved supervisory ability. Desires permanent responsible position with progressive, congenial organization. Me-4.

Industrial Relations Engineer, graduate, heavy experience in multiplant-union negotiations and personnel supervision. Experience in recruiting executive, engineering personnel and college students. Location and salary open. Me-5.

Mechanical Engineer, 43, 20 years' diversified experience factory and power-plant design, construction, management, maintenance. Process, piping, vessels, materials handling, labor relations, atomic energy. Law degree, licensed N. Y. and Calif. Me-6.

Engineer, BME, 10 years' diversified experience. Administrative and project engineer light manufacturing and engineering company. Power-plant and equipment layout, structural design. Desires responsible position with small or medium-size manufacturing unit. Me-7.

Mechanical Engineer, 32, registered, 10 years' experience industrial-plant design, construction, and operation. Management and supervision experience. Presently employed, interested in opportunity in West or Southwest. Me-9.

Project Engineer, BSME, 1948, product-development experience, pneumatics, hydraulics, servomechanisms, aircraft controls. Desires position with future in project, administrative, or sales engineering. N. Y.-N. J. area. Me-10.

[1] All men listed hold some form of ASME membership.

Positions Available

Engineers. (*a*) Assistant quality-control director, 30–40, mechanical or electrical, at least five years' experience supervising quality-control engineers, inspection staff, test and service facilities and shop-training program, covering production of electromechanical devices. $7000–$8000. (*b*) Technical assistant, under 30, quality-control experience covering electrical and mechanical components. $4118. Queens, N. Y. Y-8815. Mr. Parker.

Manager of Manufacturing, 35–45, mechanical graduate, at least 10 years' management and production experience in mining-equipment or heavy machinery fields, to assist vice-president in charge of manufacturing, covering supervision of 4000 people. Up to $30,000. Midwest. Y-9020.

Chief Engineer, 30–40, graduate, preferably BS in mechanical engineering, preferably with some job-shop experience. Responsible for all engineering functions, including design, research, and development, compilation of adequate manufacturing information, method improvement and supervision of drafting department for manufacturer of refrigeration accessories. Salary open. Md. Y-9023.

Chief Industrial Engineer, 32–37, graduate industrial engineer who has had some experience in the consumer-goods manufacturing industry. Should have had 5 to 10 years' experience in industrial engineering and some production-management experience. Prefer some of this experience to have been in metalworking. Company manufactures builders' hardware. $9000, plus profit sharing. Company will pay placement fee, traveling, and moving expenses. Calif. Y-9032.

Engineers. (*a*) Mechanical engineer, 32–42, graduate, at least eight years' experience in design and plant-engineering fields, to head up group in mechanical research and development covering textile machinery. $10,000–$12,000. (*b*) Mechanical engineering, young, graduate, experience in machinery-design fields. $6000–$7000. N. J. Y-9037.

Production Engineer, mechanical, to look after mechanical part of work and the electrical machinery. Will supervise engineering of machinery, etc. Company manufactures coated-wall-covering fabrics and some experience in coated fabrics is desirable. $9000–$12,000. N. Y. State. Y-9052.

Production Engineer to head finishing department which includes embossing, printing, and combining operations. $10,000. Mass. Y-9067

Manager of Manufacturing, 38–50, mechanical degree, additional training in metallurgy, industrial engineering, business administration helpful. Should have experience in mass production of precision products of high-alloy steels. Knowledge of tool design, modern high-speed automatic machinery, including multistation presses, progressive tools and dies, high-speed precision grinding. Will supervise all manufacturing departments; production and material control; maintenance of plant and operating facilities; inspection. Position will lead to general manager of operations. To $25,000, plus service benefits. N. Y. metropolitan area. Y-9098. Mr. Meyer.

Quality-Control Engineer, mechanical degree, specialized in metallurgy with some training in the fields of applied mechanics, inspection procedures, and test methods. Company manufactures drilling bits for the oil industry. Will be responsible for quality control of the manufacturing products. Salary open. Texas. Y-9101.

Project Engineer, 30–40, mechanical graduate, experience in machine-tool field, for design, development, and production of jet-engine blades. Must be U. S. citizen. $7000–$9000, plus overtime. Central N. Y. State. Y-9105.

Engineer, PhD or equivalent with practical research experience in mechanical and/or electrical field, to head engineering department doing research, development, and handling complex field-service engineering problems. $9000–$12,000. East. Y-9115.

Mechanical Engineer, BS degree and practical experience in industry, engineering, or design, to do design work in connection with a small research organization. Should have experience in the use of toolroom equipment. Opportunity to study for advanced degree. $5000–$7000. Va. Y-9118(*a*).

Engineers. (*a*) Industrial engineer, under 30, methods and survey experience, to analyze operations of cargo handling, improve systems, and procedures for airline. $4860–$5100. (*b*) Junior time and motion-study engineer, under 30, to make time studies. $4680–$5400. (*c*) Senior time and motion-study engineer, under 35, for operational analysis and methods improvement covering reservations and ticket sales. Considerable travel. $5640–$6300. Headquarters, New York, N. Y. Y-9119.

Plant Manager, 35–40, engineering training and experience in dry-cell battery field, to take charge of operations and maintenance of battery manufacturing plant. $8000–$10,000. Philippines. Y-9122.

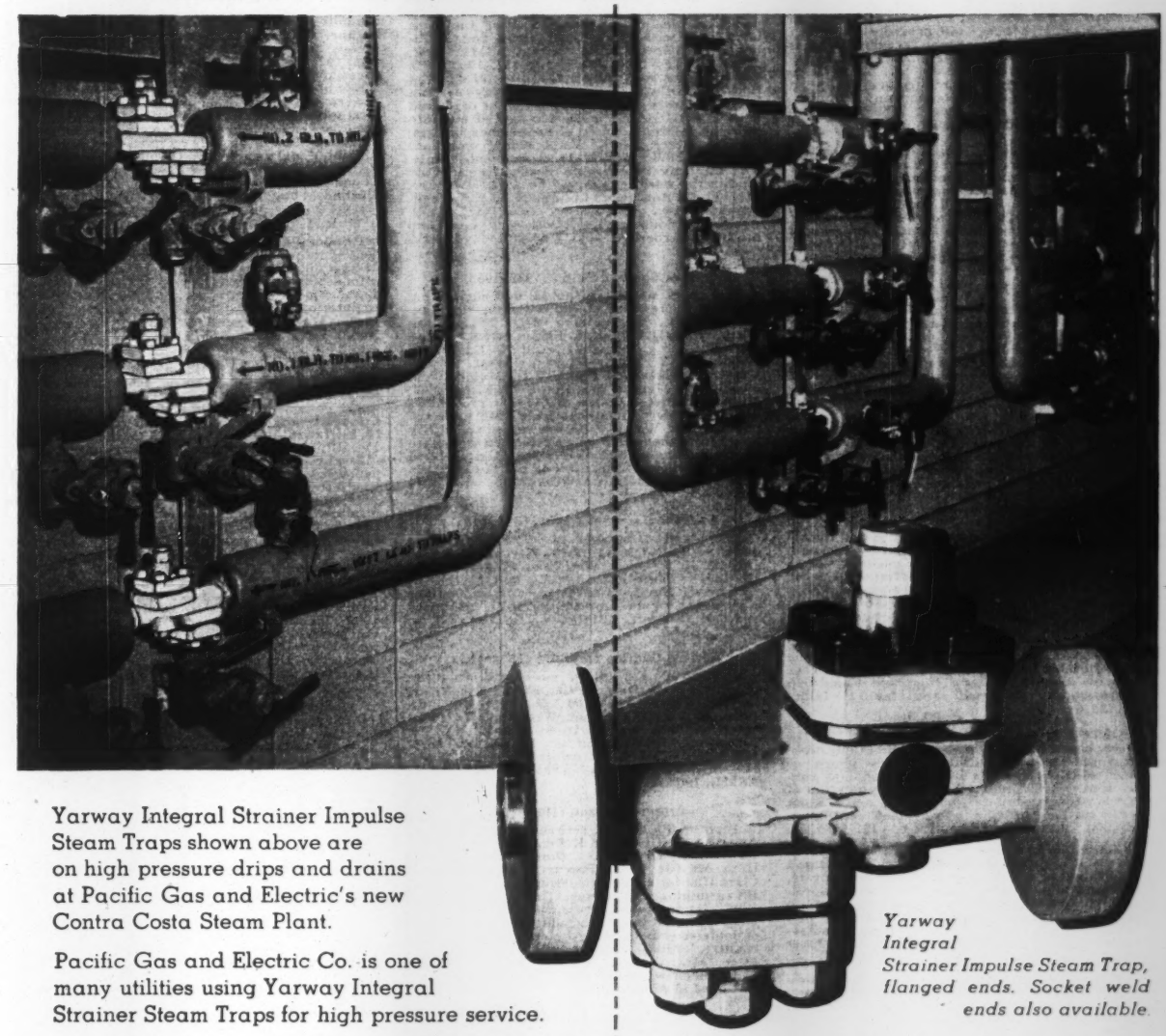
Director of Engineering, 35–45, mechanical or electrical degree, knowledge of tooling, drafting, design; service. Working knowledge of patents. Proved administrative ability. Knowledge of budgets and costs. Company manufactures complete line of precision equipment and apparatus. Will be responsible for all engineering departments, including research and development; testing laboratory; service engineering; industrial engineering; tool engineering and design. Up to $18,000, plus incentive bonus. Central N. Y. State. Y-9125.

Designer-Draftsman, at least three years' experience in special machine design of sheet metalworking field. Knowledge of gears, mathematics, and angles. Will supervise two draftsmen in special machine development in sheet metalworking field for a manufacturer. $6500. Employer will negotiate placement fee. Ill. C-1196.

Chief Engineer, 28–50, at least three years' experience in high-speed precision equipment and

(*ASME News continued on page 858*)

trapping high pressure drips and drains at P. G. and E.



Yarway Integral Strainer Impulse Steam Traps shown above are on high pressure drips and drains at Pacific Gas and Electric's new Contra Costa Steam Plant.

Pacific Gas and Electric Co. is one of many utilities using Yarway Integral Strainer Steam Traps for high pressure service.

Yarway Integral Strainer Impulse Steam Trap, flanged ends. Socket weld ends also available.

Yarway Impulse Steam Traps drain some of the hottest steam lines in the country . . . and meet all requirements on pressures up to 1500 psi. They have ample capacity when system is being "warmed up"—yet will handle relatively small amounts of high temperature condensate without losing prime. In presence of dry or superheated steam, the trap valve closes.

Small size simplifies installation. No special supports needed (see picture).
Easy maintenance—only one moving part.
For full details, send for Yarway Bulletin T-1740.

YARNALL-WARING COMPANY • 108 Mermaid Avenue, Philadelphia 18, Pa.

[redacted] **impulse steam trap**

preferably sewing machines. Knowledge of cams and gears. Will head up engineering and development and personnel ranging from modelmakers and technicians up to actual engineering help for a manufacturer of special machines. Up to $10-000. Employer will negotiate placement fee. Ill. C-1204.

District Manager, to 45, some experience in industrial insulation field and some experience in plumbing and heating and/or industrial-piping estimating. Should be able to take off quantities on piping and areas of equipment. Work with distributor in territory as well as contact large industrial users, contact architectural engineers, to encourage specification of company's product. Travel 10 states in Midwest. $7200 plus expenses. Headquarters, Texas. C-1210.

Safety Engineer, BS, BA in ChE, or Chemistry, over 28, five years' responsible industrial safety experience in chemical-manufacturing plant. Knowledge of chemical-engineering procedures and safety methods. Will formulate "selling" and carrying out comprehensive safety program. Will be given responsibility for safety program of large division of company, expected to direct work of others in division safety department for manufacturer of chemicals. $6000–$8000. Mo. C-1213.

Project Engineer, mechanical, 28–35, at least two years' experience in power-plant operations, design, or installation. Knowledge of power plants. Will conduct power-plant surveys for operating data, steam-plant efficiency acceptance tests, and expansion projects, for general construction consultants. $7500–$8500. Employer will pay fee. Ill. C-1214.

Engineers. (*c*) Industrial-engineering consultant, up to 70, five years' experience in standards and methods, time study, inspection of materials, quality control, specifications, tool and fixtures design, plant layout, materials handling, and processing. One-year contract. Will serve as consultant on above phases of industrial engineering. Must be U. S. citizen. $9600–$12,000, plus 25 per cent overseas bonus, cost of living, and round-trip transportation for self and family. Lebanon. (*g*) Manufacturing-development engineer, up to 70, five years' experience manufacturing facilities, research for small industries. One-year contract. Must be U. S. citizen. Knowledge of electrical equipment and power. Will advise small or cottage industries on methods for improving production through electrical equipment, resources, skills, needs, and available power. Must be able to train labor. $9600–$12,000, plus 25 per cent overseas bonus, cost of living, and round-trip transportation for self and family. India. C-1224.

Office Engineer, over 40, mechanical, five or more years' experience in power-plant piping problems and preferably utilities, process plants, or steel mills' supervision of construction for contractors. Will contact prospects, preparation of specifications, estimates, purchasing and contact with customers for a power-plant contractor. $20,000. Employer will pay fee. Ill. C-1234.

Chief Design Engineer, up to 50, mechanical, at least 10 years' experience in development and application of engineering principles of intricate, precision mechanisms. Will direct and co-ordinate four or five engineering departments, establish policies, procedures, standards, and develop new products in the photographic field for a manufacturer of cameras. $12,000–$16,000. Employer will negotiate placement fee. Ill. C-1257.

Machine-Shop Supervision, 32–45, mechanical degree, 10 years' experience in machine-shop supervision and production control; for a foundry and machine shop. $10,000–$15,000 Ill. C-1273.

Obituaries

Homer Addams (1873–1953)

HOMER ADDAMS, chairman of the board of directors, Fitzgibbons Boiler Co., Inc., New York, N. Y., died July 3, 1953. His home was in Germantown, Pa. Born, Adamstown, Pa., June 22, 1873. Parents, Jacob and Anna Addams. Education, Schuylkill Seminary (Later absorbed by the school that became Albright College); hon. DS, Albright College, 1951. Married Elizabeth Swartz, 1898; son, Paul K. In 1894 he was one of the founders of the American Society of Heating and Ventilating Engineers; president, 1924. Mem. ASME, 1928. He was one of the founders of the Steel Boiler Institute in 1929; eventually he served as president. He also was a member of the Uniform Boiler Law Society. In 1952 he received the F. Paul Anderson Gold Medal awarded by ASHVE.

George Wood Bacon (1869–1953)

GEORGE W. BACON, retired in 1946 as chairman of the board of Ford, Bacon & Davis, Inc., New York, N. Y., died in Pasadena, Calif., July 21, 1953. Born, Greenwich, N. J., May 6, 1869. Parents, Josiah and Caroline (Wood) Bacon. Education, ME, Cornell University, 1892; hon. DS, Trinity College, 1936. Married Caroline Tilden Mitchell, 1904, died 1931; together they had been among the cofounders of the New School of Social Research. Married 2nd, Elizabeth Ann Mitchell, 1943. Assoc. ASME, 1898; Mem. ASME, 1899; Fellow ASME 1941. He was identified with the electrification of much of the New Orleans, La., street-railway system. From this work the company which he organized with Frank R. Ford in 1894 branched out into other fields—construction of power lines, bridges, tunnels, power plants, World War I munitions plants, and World War II atom bomb plants. The company became one of the largest of its kind in the world. Survived by wife; daughter, Mrs. F. K. Rodewald, Elmira, N. Y.; a granddaughter; two grandsons; a sister, Mrs. W. S. Atkinson, South Laguna, Calif.; and two brothers, Herbert M. and J. Cortland, of Berkeley, Calif.

Alfred Edward Ballin (1882–1953)

ALFRED E. BALLIN, industrial and engineering consultant, president of Balco Engineering Co., Tulsa, Okla., died March 23, 1953. Born, Washington, D. C., Oct. 3, 1882. Parents, Ralph and Ellen S. (Turnbull) Ballin. Education, Buffalo, N. Y., public schools; 1 year, Cornell University. Married Florence H. Mabie, 1906, died 1951. Married 2nd, Dorothy Watson, 1952. He was district manager of the war production board of eastern Oklahoma from 1940 until the end of World War II. He also served the utility board from the time it was established in 1946 to supervise the second Spavinaw (Okla.) bond project until his term expired in 1951. Assoc. ASME, 1906; Mem. ASME, 1938. His wife survives.

Spencer Harwood Davis (1891–1953)

SPENCER H. DAVIS, mechanical and structural designer, Philadelphia (Pa.) Electric Co., died July 25, 1953. Born, West Stafford, Conn., Oct. 13, 1891. Parents, George W. and Myrtie D. (Harwood) Davis. Education, PhB in sanitary engineering, Yale University, 1912. Married Pearl H. Stewart, 1914; son, Spencer H., Jr. Mem. ASME, 1943.

Edward Charles DeWolfe (1874–1953)

EDWARD C. DEWOLFE, mechanical engineer, proprietor of the DeWolfe (industrial) Advertising Service, River Grove, Ill., died July 5, 1953. Born, Michigan City, Ind., Feb. 16, 1874. Parents, Joseph E. and Gertrude (Ward) DeWolfe. Education, BSME, Purdue University, 1896; ME, 1901. Married Adaline M. Wells, 1898; son, Edward W. Jun. ASME, 1899; Assoc. ASME, 1906.

Arthur Erickson (1883–1953)

ARTHUR ERICKSON, retired design engineer, American Smelting and Refining Co. at Garfield, N. J., died July 8, 1953. Born, Salt Lake City, Utah, May 31, 1883. Parents, Carl Auguste and Clara Charlotte (Broms) Erickson. Education, BS in mining engineering, University of Utah, 1906. He was an important figure in the development of many metals installations and designer of nonferrous metallurgical plants throughout the country. Mem ASME, 1926. Survived by a niece, Mrs. Peter J. Bogden, Salt Lake City; and a nephew, Lieut. Col. Walter L. Winegar, stationed in Alaska.

Frank Leslie Estep (1876–1952)

FRANK L. ESTEP, consulting engineer, Barium Steel Corp., New York, N. Y., died Dec. 11, 1952. Born, Jeffersonville, Ohio, Aug. 20, 1876. Parents, Robert W. and Mary (Bouse) Estep. Education EE, Ohio State University, 1898; ME, OSU. Married Genevieve Wooding, 1906. Married 2nd, Mary E. Youngwall. Mem. ASME, 1919.

Edwin D. A. Frank (1883–1953)

EDWIN D. A. FRANK, designer of centrifugal pumps, steam and water jet apparatus, and turbines, Ampco Metal, Inc., Milwaukee, Wis., died April 28, 1953. Born, Milwaukee, Wis., July 27, 1883. Parents, Louis F. and Emilie J. (Inbusch) Frank. Education, BS, Massachusetts Institute of Technology, 1906; postgraduate work at Technische Hochschule, Aachen, Germany, and University of Illinois. Married Marie Louise Meinecke, 1919. Jun. ASME, 1909; Mem. ASME, 1925. Member of The Franklin Institute of Pennsylvania. Survived by wife.

Thomas Francis Githens (1889–1953)

THOMAS F. GITHENS, mechanical engineer, charge of engineering, Cleveland (Ohio) Twist Drill Co., died June 29, 1953, at Lakeside Hospital in Cleveland. Born, New York, N. Y., Oct. 9, 1889. Parents, William F. and Cecelia (McMorrow) Githens. Education, BS, College of the City of New York, 1909; MA(ME), Columbia University, 1913. Married Marion Eschmann, 1917. Jun. ASME, 1915; Assoc. Mem. ASME, 1917; Mem. ASME, 1924; Fellow ASME, 1952. He served the Society on the following ASME committees: chairman, Machine Design Division; member, Research Committee on the Cutting of Metals; secretary and chairman, Cleveland Section, 1927–1928; chairman or member of various Cleveland Section local committees. He was also active in the affairs of the Cleveland Engineering Society and many other professional and technical societies. He was the author of several technical papers and held U. S. Patents covering just a fraction of his work. He received the Columbia Alumni Medal awarded by Columbia University, February, 1939. Survived by wife; a son, Lieut. Thomas F., Jr.; and two daughters, Mrs. Ned I. Kuehngold and Therese Ann.

Rudolph Conrad Goebel (1892–1953)

RUDOLPH C. GOEBEL, mechanical superintendent, Minneapolis and St. Louis Railway Co., Minneapolis, Minn., died June 9, 1953. Born, Minneapolis, March 14, 1892. Parents, Conrad J. and Emelia (Ryen) Goebel. Education, BS in engineering, University of Minnesota, 1913; EE, 1914. Married Loretta T. Mayers; daughter, Nancy Lou. Mem. ASME, 1942.

Louis Allen Harding (1876–1953)

LOUIS A. HARDING, engineer, scholar, and educator, who was known as Buffalo's ablest public works commissioner, and treasurer, Leach Steel Co., Rochester, N. Y., died at his home in Buffalo, N. Y., July 8, 1953. Born, Factoryville, Pa., Oct. 16, 1876. Parents, Henry L. and Luzette I. (Maynard) Harding. Education, BS, Pennsylvania State College, 1899; ME, 1902. Married Charlotte Hanes Phelps, 1923. Mem. ASME, 1913; Fellow ASME, 1943. He was a founder member of the Buffalo unit of the American Society of Heating and Ventilating Engineers and served as national president in 1930. He was contributor of the sections on mechanical equipment of buildings; heating, ventilating, and air conditioning; and steam-power plant engineering of Kent's "Mechanical Engineers' Handbook"; author of Heating and Air-Conditioning Manual, 1935. Since his retirement several years ago from the public works commissionership, when he returned to private practice, he had written a book on mathematics and another on navigation. He is survived by his wife.

Albert Oscar Jadot (1899–1953)

ALBERT O. JADOT, formerly president of the Faculté Polytechnique, Mons, Belgium, died June 16, 1953, at New Britain, Conn., where he had been making his home since his retirement in 1952. Born, Huy, Belgium, April 19, 1899. Parents, Joseph and Emma (Colard) Jadot. Education, ME, University of Liège, 1921; EE, 1922; MME, Cornell University, 1923. Married Jeanne Schmitz, 1924 (divorced 1952); children, Marie-Jeanne, Madeleine, Jean, Francine. Married 2nd, Evelyn Ferry, 1952. He was the author of 40 technical papers on gas turbines, ventilation, various mechanical and diesel engines; in 1931 his book on gas motors was published. In 1936 he was Lauréat du Prix Bolle from the Mons Association of Engineers. He was president of the "Ventilateurs" Commission of the Belgium Society of Mechanical Engineers; reporter, "Moteurs à Injection" Commission. He was a member of the board of the Fondation universitaire, the Fonds national de la Recherche Scientifique, and Inichar (Research Board for the Coal Industry), and many others. After World War II, he made several official missions to the United States in order to study the progress in ventilators, diesel engines, and gas turbines. He was vice-president of the Mechanics Section of the Centenary of the Association of Graduate Engineers of the University of Liège, 1947. He was awarded the Croix civique, 1914–1918. His activities in the Belgian underground during World War II, as second in command of the Hainaut-Namur Section of the Belgian Partisans' Army, won for him in 1947 the Croix de Guerre, with palms, and the Resistance Medal. In 1949 he was awarded the Médaille civique de 1ère classe. He was commander de l'Ordre de la Couronne; officier de l'Ordre de Léopold. Mem ASME, 1946. Since 1947 he served as Foreign Associate of ASME Gas Turbine Power Division. He was on the board of trustees, Institute National de l'Industrie Charbonnière; president and founder member, Belgian Gas Turbine Committee; member, Institution of Mechanical Engineers (Great Britain); president, Mons Branch of Association Belgo-Américaine; member, Engineering Societies of Liège and Mons. Survived by wife, Evelyn Ferry Jadot; four children in Belgium, Mme. Max

(*ASME News continued on page 860*)

STEAM COST REDUCED

At Chemical Plant with Detroit RotoGrate Stoker!

Write for this coal saving reprint. No obligation.

Handling High Peaks at Low Cost in Coal Fired Virginia Plant

American Cyanamid Company
Calco Chemical Division—Piney River, Virginia

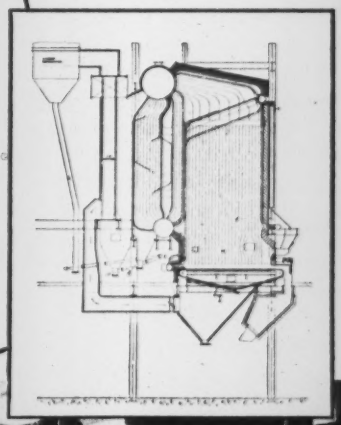
By C. A. Reed, Director of Engineering, National Coal Association
Photographs by Clifford H. Adams, Staff Photographer, Bituminous Coal Institute

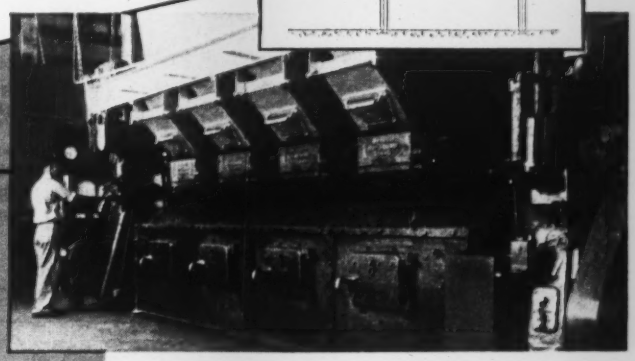
Operating record of this Virginia plant confirms design estimate of 85 per cent efficiency. Steam costs were lowered to 65 cents per thousand, including depreciation, operation, and maintenance.

REPRINTED FROM SOUTHERN POWER & INDUSTRY

Compliments of DETROIT STOKER COMPANY, Detroit, Michigan

Sudden load surges from 50,000 to 90,000 pounds of steam per hour easily handled. Detroit RotoGrate with Riley two drum steam generator. Air preheated to 310° to 345° F.





DETROIT SINCE 1898 STOKERS

DETROIT STOKER COMPANY

General Motors Bldg. • Detroit 2, Mich.

Works at Monroe, Mich. • District Offices in Principal Cities

Toubeau, Liège; Mme. Georges Lefebvre, Marchienne-au-Pont; Jean and Francine Jadot, Mons.

Lloyd Balderston Jones (1882–1953)

LLOYD B. JONES, retired engineer of tests, in charge of test and material inspection, Pennsylvania Railroad, died June 7, 1953. Born, West Grove, Pa., Sept. 30, 1882. Parents, S. Morris and Jane (Balderston) Jones. Education, ME, Cornell University, 1904. Married Luella L. Walker, 1907; children, Charles W., Helen H. (deceased), Margaret F. He held 15 U. S. Patents dealing with railroad machinery and equipment. Mem. ASME, 1916; Fellow ASME, 1947.

Frederick Kalmbach, Sr. (1879–1953)

FREDERICK KALMBACH, SR., chairman of the board of General Machine Co. and of Electric Furnace-Man, Inc., died July 31, 1953, at his home in Macungie, Pa. Born, Altensteig, Germany, Aug. 10, 1879. Parents, Johannes and Eva Maria Kalmbach. Education, grammar and continuation schools. Mem. ASME, 1928. A leader in the anthracite-heating industry, Mr. Kalmbach was an original partner in the General Machine Co which, in 1923, manufactured the first domestic anthracite stoker, known as Electric Furnace-Man. In 1933, Mr. Kalmbach formed Electric Furnace-Man, Inc., both to manufacture and sell anthracite-conversion units. He was a member of the Steuben Society, the Lehigh Valley Engineers Club, and the Lehigh County Historical Society. Survived by his wife, Anna; a son, Frederick W., Jr.; two brothers, Albert and William; and three sisters, Mrs. Freida Schildhauer, Mrs. Louisa Schilling, and Mrs. Marie Zirkmann.

George Ilgenfritz King (1871–1953)

GEORGE I. KING, retired engineering executive, died June 5, 1953. Born, York, Pa., April 9, 1871. Parents, Arthur and Lydia A. (Ilgenfritz) King. Education, preparatory school; Massachusetts Institute of Technology, 1889–1891, 1896–1897. Married Emma Kate Campbell, 1898; children, Marion C., George I., Jr., Lucile C., Eleanor C., Robert E., John S. He had taken out nearly 100 patents in the United States and other countries covering steel railway cars and parts. He was first to claim invention of steel Z-bar side frames for box and coal cars of which many thousands are now in use. He was influential in introducing standards of American Master Car Builders' Association on state railways in South America and Russia. Author of "Handbook for Estimating Cost of Steel Cars," catalogs, and articles for several technical publications.

Richard William Maffett (1929–1953)

RICHARD W. MAFFETT, lieutenant, project engineer, Experimental Track Branch, USAF, Edwards AFB in California, died Jan. 15, 1953, according to recent information sent to the Society. Born, Indianapolis, Ind., Dec. 3, 1929. Education, BS(ME), Purdue University, 1952. Jun. ASME, 1952.

John Gephart Munson (1885–1952)

JOHN G. MUNSON, vice-president, United States Steel Corp. of Delaware since 1939, died March 29, 1952, according to a notice recently received by the Society. Born, Bellefonte, Pa., Jan. 6, 1885. Parents, Lorenzo T. and Sarah (Gephart) Munson. Education BS, Yale University, 1905. Married Eliza Short, 1911; children, John G., Jr., Alice Elizabeth. Mem. ASME, 1917.

Keene Richards (1888–1953)

KEENE RICHARDS, general manager, Vassar College, Poughkeepsie, N. Y., consulting engineer and director, Dutchess County Civil Defense, died July 6, 1953. Born, Chicago, Ill., Dec. 24, 1888. Parents, John T. and Lucy (Keene) Richards. Education, 3 years, University of Illinois. Married Jennie Parker, 1911; children, Elizabeth, Janet. Author: various articles for technical and yachting press. Mem. ASME, 1927.

Anthony Frank Schwendner (1891–1953)

A. FRANK SCHWENDNER, advisory engineer, Westinghouse Electric Corp., Philadelphia, Pa., died June 12, 1953. Born, Budapest, Hungary, Nov. 29, 1891. Parents, Anthony and Barbara (Warnus) Schwendner. Education, graduate, Technische Hochschule. Naturalized U. S. Citizen, Philadelphia, Pa., April 25, 1923. Married Elizabeth Stempel, 1918; children, Betty, Doris, Robert. He held 18 U. S. Patents pertaining to governors and regulators and his papers were published in the various professional journals. Mem. ASME, 1940. He served on the Society's Power Test Code No. 20 on Speed, Pressure, and Temperature Governors.

Russell Severance Springer (1880–1953)

RUSSELL S. SPRINGER, retired engineer of San Francisco, Calif., died July 1, 1953. Born, San Francisco, Aug. 25, 1880. Education, BS(ME), University of California, 1902. Mem. ASME, 1913.

James Stark Train (1896–1953)

JAMES S. TRAIN, joint managing director, John Thompson (Australia) Pty., Ltd., Melbourne, died at sea May 6, 1953, while en route to England. Born, Carluke, Scotland. Education, Wolverhampton Technical College, 1920; diploma in fuel technology, Glasgow Technical College, 1923. Mem. ASME, 1949. He presented many papers on welding, combustion, and water treatment, which were published, before the Institution of Engineers, Australia; Mechanical Engineers Association of Australia, and Sydney Technical College.

Nathan Rowland Wickersham (1874–1953)

NATHAN R. WICKERSHAM, retired in 1945 as general superintendent, Ingersoll-Rand Co., Painted Post, N. Y., died July 28, 1953. Born, Philadelphia, Pa., Feb. 7, 1874. Parents, John M. K. and Florence (Rowland) Wickersham. Education, high-school graduate; attended evening sessions, The Franklin Institute and Drexel Institute of Technology. Married Ellen P. Wyncoop, 1898; children, Leonore E., Nathan R., Jr., Roland deB. President, American Red Cross, police commissioner, and chairman, War Liberty Loan, all in Corning, N. Y., where he made his home. Mem. ASME, 1907. He held several U. S. patents on his inventions.

Keep Your ASME Records Up to Date

ASME Secretary's office in New York depends on a master membership file to maintain contact with individual members. This file is referred to dozens of times every day as a source of information important to the Society and to the members involved. All other Society records and files are kept up to date by incorporating in them changes made in the master file.

From the master file are made the lists of members registered in the Professional Divisions. Many Divisions issue newsletters, notices of meetings, and other materials of specific interest to persons registered in these Divisions. If you wish to receive such information, you should be registered in the Divisions (no more than three) in which you are interested. Your membership card bears key letters opposite your address which indicate the Divisions in which you are registered. Consult the form on this page for the meaning of the letters. If you wish to change the Divisions in which you are registered, please notify the Secretary's office.

It is important to you and to the Society to be sure that your latest mailing address, business connection, and Professional Divisions' enrollment are correct. Please check whether you wish mail sent to home or office address.

For your convenience a form for reporting this information is printed on this page. Please use it to keep the master file up to date.

Four weeks are required to complete master-file changes.

ASME Master-File Information

(Not for use of student members)

Please print **Check mailing address**

Name ..... (Last, First, Middle)

Home address ..... ☐ (Street, City, Zone, State)

Name of employer .....

Address of employer ..... ☐ (Street, City, Zone, State)

Product or service of company .....

Title of position held .....

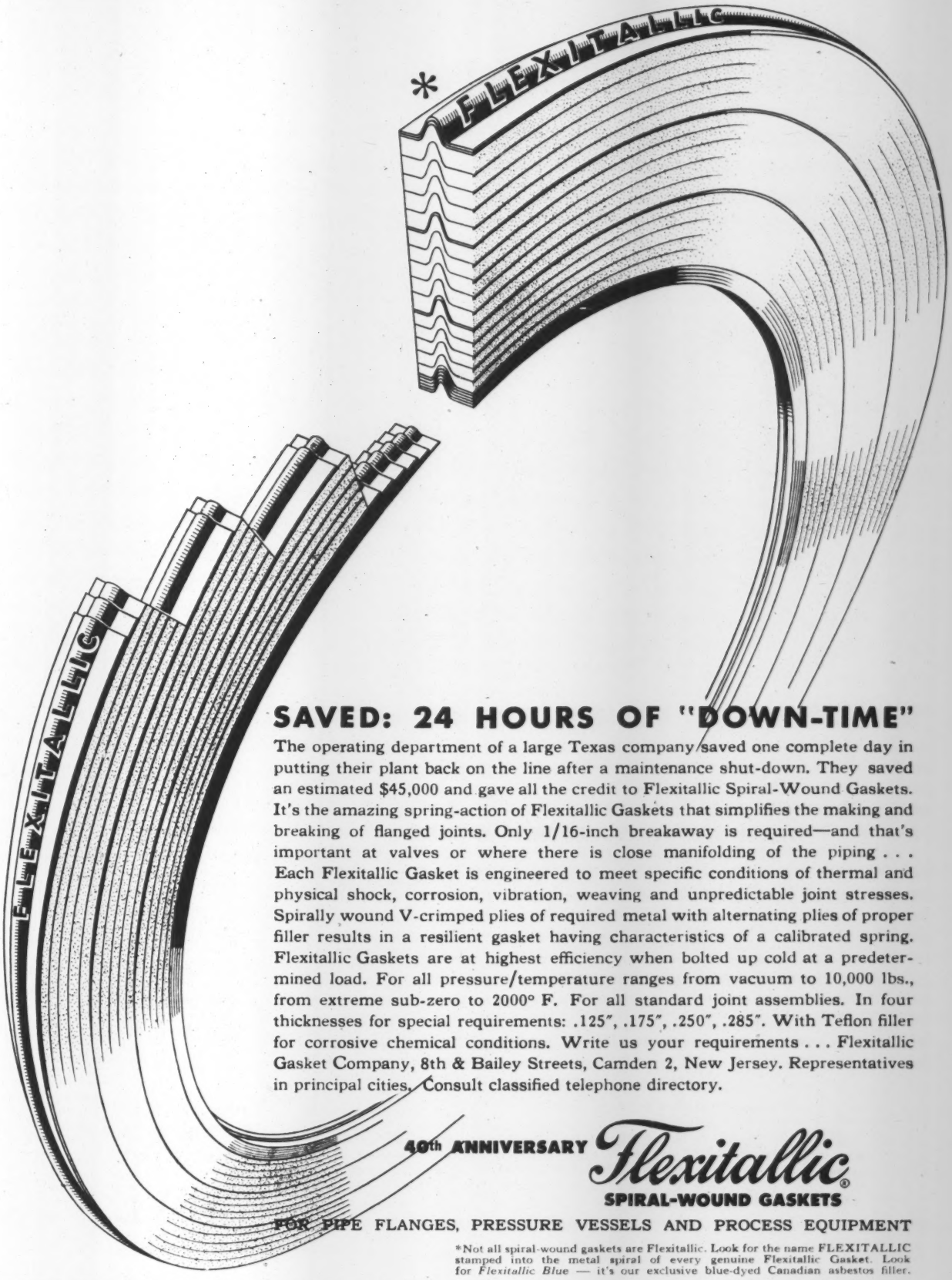
Nature of work done .....

Please register me in three Professional Divisions as checked:

☐ A—Aviation	☐ J—Metals Engineering	☐ S—Power
☐ B—Applied Mechanics	☐ K—Heat Transfer	☐ T—Textile
☐ C—Management	☐ L—Process Industries	☐ V—Gas Turbine Power
☐ D—Materials Handling	☐ M—Production Engineering	☐ W—Wood Industries
☐ E—Oil and Gas Power	☐ N—Machine Design	☐ Y—Rubber & Plastics
☐ F—Fuels	☐ P—Petroleum	☐ Z—Instruments and Regulators
☐ H—Hydraulics	☐ R—Railroad	

I am a subscriber to (please check)

Transactions.. ☐ Journal of Applied Mechanics.. ☐ Applied Mechanics Reviews.. ☐



SAVED: 24 HOURS OF "DOWN-TIME"

The operating department of a large Texas company saved one complete day in putting their plant back on the line after a maintenance shut-down. They saved an estimated $45,000 and gave all the credit to Flexitallic Spiral-Wound Gaskets. It's the amazing spring-action of Flexitallic Gaskets that simplifies the making and breaking of flanged joints. Only 1/16-inch breakaway is required—and that's important at valves or where there is close manifolding of the piping . . . Each Flexitallic Gasket is engineered to meet specific conditions of thermal and physical shock, corrosion, vibration, weaving and unpredictable joint stresses. Spirally wound V-crimped plies of required metal with alternating plies of proper filler results in a resilient gasket having characteristics of a calibrated spring. Flexitallic Gaskets are at highest efficiency when bolted up cold at a predetermined load. For all pressure/temperature ranges from vacuum to 10,000 lbs., from extreme sub-zero to 2000° F. For all standard joint assemblies. In four thicknesses for special requirements: .125", .175", .250", .285". With Teflon filler for corrosive chemical conditions. Write us your requirements . . . Flexitallic Gasket Company, 8th & Bailey Streets, Camden 2, New Jersey. Representatives in principal cities. Consult classified telephone directory.

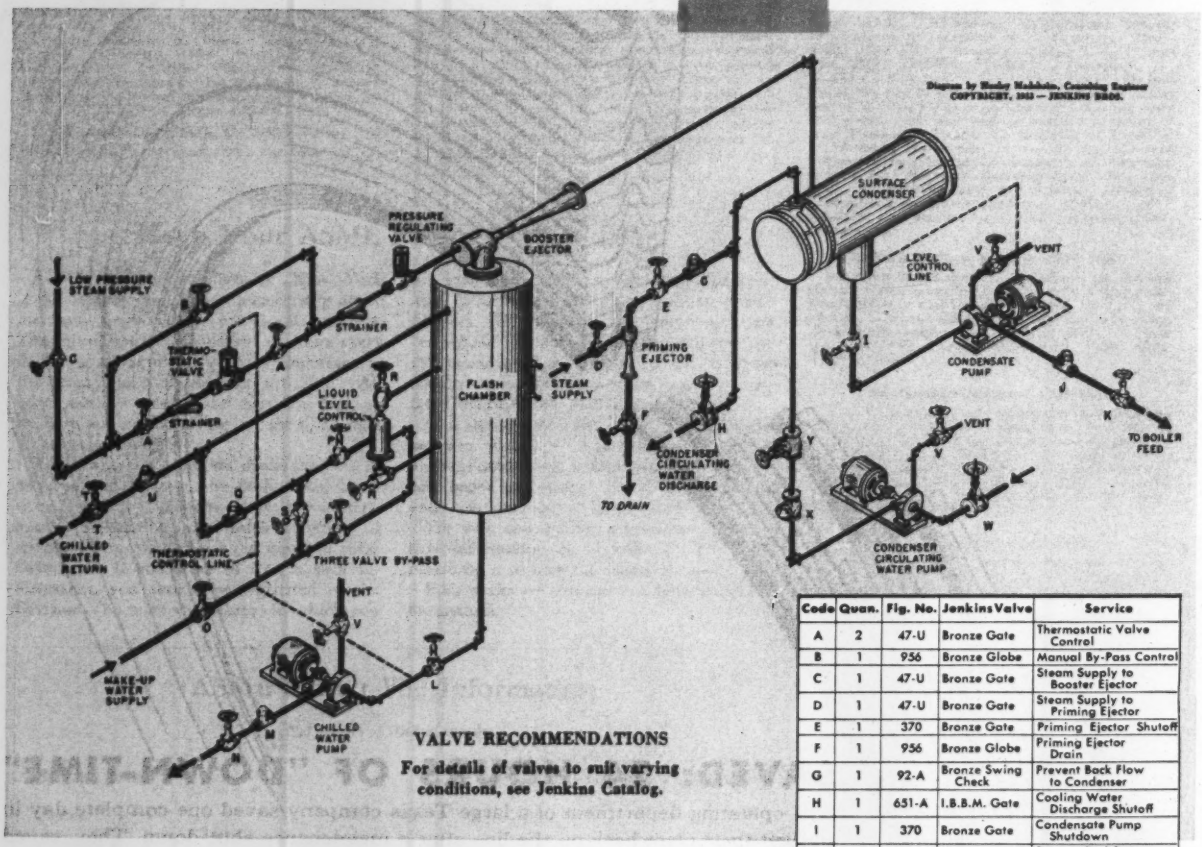
40th ANNIVERSARY *Flexitallic*®

SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

*Not all spiral-wound gaskets are Flexitallic. Look for the name FLEXITALLIC stamped into the metal spiral of every genuine Flexitallic Gasket. Look for *Flexitallic Blue* — it's our exclusive blue-dyed Canadian asbestos filler.

JENKINS PRACTICAL PIPING LAYOUTS 69



VALVE RECOMMENDATIONS

For details of valves to suit varying conditions, see Jenkins Catalog.

Code	Quan.	Fig. No.	Jenkins Valve	Service
A	2	47-U	Bronze Gate	Thermostatic Valve Control
B	1	956	Bronze Globe	Manual By-Pass Control
C	1	47-U	Bronze Gate	Steam Supply to Booster Ejector
D	1	47-U	Bronze Gate	Steam Supply to Priming Ejector
E	1	370	Bronze Gate	Priming Ejector Shutoff
F	1	956	Bronze Globe	Priming Ejector Drain
G	1	92-A	Bronze Swing Check	Prevent Back Flow to Condenser
H	1	651-A	I.B.B.M. Gate	Cooling Water Discharge Shutoff
I	1	370	Bronze Gate	Condensate Pump Shutdown
J	1	92-A	Bronze Swing Check	Prevent Backflow through Condensate Pump
K	1	106-A	Bronze Globe	Condensate Pump Control
L	1	370	Bronze Gate	Chilled Water Pump Shutdown
M	1	92-A	Bronze Swing Check	Prevent Back Flow Through Pump
N	1	106-A	Bronze Globe	Chilled Water Pump Control
O	1	106-A	Bronze Globe	Make-up Water Control
P	2	370	Bronze Gate	Automatic Valve By-Pass
Q	1	92-A	Bronze Swing Check	Prevent Backflow from Chamber
R	2	108-A	Bronze Angle	Level Control Shutoff
S	1	106-A	Bronze Globe	Manual By-Pass Control
T	1	106-A	Bronze Globe	Chilled Water Control
U	1	92-A	Bronze Swing Check	Prevent Backflow Chilled Water Lines
V	1	106-A	Bronze Globe	Pump Vent
W	1	651-A	I.B.B.M. Gate	Condensing Water Pump Shutdown
X	1	624	I.B.B.M. Swing Check	Prevent Backflow to Pump
Y	1	613	I.B.B.M. Globe	Pump Control

How to plan a

STEAM JET REFRIGERATION SYSTEM

The use of steam for air conditioning has increased steadily during the past few years, principally because of the low cost of steam. In plants generating their own steam, demands on the boiler plant are greatly reduced during the summer months, while plants having to purchase district steam usually benefit by reduced summer rates.

In the steam jet system shown, water returned from the chilled water coils of the air conditioning system enters the flash chamber which is maintained at a low pressure by the booster ejector. Here the water is cooled to a temperature corresponding to the boiling point at the reduced pressure. Heat is removed by the flashing of a portion of the returned water to steam which is removed by the ejector.

The booster ejector used in this system requires either a barometric or surface condenser. Pump drives may be either electric or steam turbine, depending upon local operating costs and the size of the installation.

Consultation with accredited piping engineers and contractors is recommended when planning any major piping installation.

To save time, to simplify planning, to get all the advantages of Jenkins specialized valve engineering experience, select all the valves you need from the complete Jenkins line. It's your best assurance of *lowest cost in the long run*. Jenkins Bros., 100 Park Ave., New York 17.

• •

Complete description and enlarged diagram of this layout free on request. Includes additional detailed information. Simply ask for Piping Layout No. 69.

JENKINS
LOOK FOR THE DIAMOND MARK
VALVES
SINCE 1864
Jenkins Bros

SOLD THROUGH LEADING INDUSTRIAL DISTRIBUTORS EVERYWHERE

KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

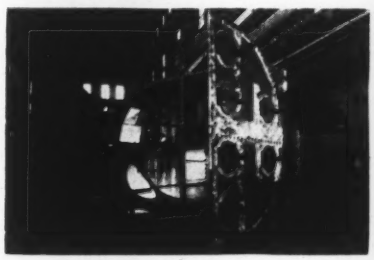
Available literature or information may be secured by writing direct to the manufacturer. Please mention MECHANICAL ENGINEERING

NEW EQUIPMENT

Waterbox for Condenser

Three unusual features to meet a new Midwestern power plant's specific requirements are combined in a front waterbox, 12 ft × 16 ft 3 in. in size, for an Allis-Chalmers 50,000-sq ft, two-pass surface condenser, shown during fabrication in the company's shops.

The distinctive aspects of this condenser waterbox are hinged covers, 30-in. motor-operated butterfly valve installed in the vertical waterbox division wall, and 90-deg elbows incorporated into the circulating water inlet connection.



The hinged water-box covers, each fabricated from 2-in. steel plate and weighing 10,500 lb, can be manipulated by one man, eliminating the need for crane facilities during retubing. Each of the halves swings on two ball-thrust bearings. The 30-in. motor-operated butterfly valve makes it possible to supply water to both halves of the condenser with one circulating water pump.

The 36-in. built-in elbows save space and make for one less connection and one less piece of equipment, Allis-Chalmers says, pointing out that elbows of this size are not generally built into a condenser waterbox.

Ball Bearings

Nice Ball Bearing Co., Philadelphia, Pa., has announced 7500 and 7600 series precision radial bearings. These bearings are single-row, solid-race type with ball retainer and incorporate a labyrinth seal to retain lubricant and exclude foreign materials. They are designed for medium loads and speeds in the neighborhood of 5000 rpm, maximum.

Both series 7500 (no extensions) and series 7600 (extended inner race with two locking set screws) can be provided with or without snap ring. Normally double sealed, series 7500 and 7600 bearings can be produced to order with seals on one side only, or without seals.

Safety-Relief Valve

Called the Lonergan Uni-Line 41-W-200 Series by J. E. Lonergan Co., Second and Race Sts., Philadelphia 6, Pa., the new valve series is claimed to have several outstanding advantages over the more conventional safety-relief valves: These features include: a higher capacity per size than any other valve; a free-acting, self-aligning disk; a "floating" guide (adjustable for control), to assist in opening and closing action, as well as to afford an additional self-aligning feature; a disk and disk holder of forged copper alloy, not castings.

Available in sizes from $1\frac{1}{2}$ in. through 6 in., Lonergan Uni-Line Valves are V&W National Board approved design. Descriptive literature will be sent on request.

A-C Motor Brake

A new single-adjustment a-c brake (Type AK) is available from the Westinghouse Electric Corp. The manufacturer states that this a-c brake combines what were three adjustments in one: (1) spring compression, to control torque; (2) magnet travel, to control total shoe clearance from wheel; and (3) auxiliary screw adjustment, to equalize shoe clearances. Also, a visible indicator has been provided to tell the maintenance crew when and how much to readjust for brake wear.

The brake is applicable to practically all a-c motor installations that demand start-stop operation or quick deceleration, such as cranes or machine tools, according to Westinghouse. Although designed for normal mounting on a horizontal plane, it will operate satisfactorily regardless of the angle of the mounting plane.

Further information can be obtained from Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.

Largest Industrial Coupling

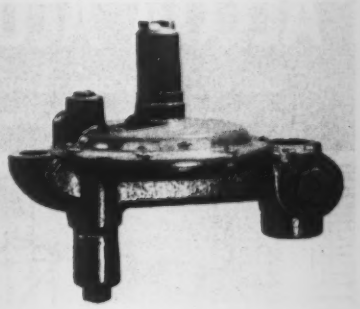
To transmit as much as 62,000 hp in straight-line at a huge steel plant plate mill, what is said to be the world's largest industrial self-aligning coupling has been built by Koppers Co., Inc.

The all-metal coupling was made in the Fast's Coupling Dept. of Koppers Co., Inc. Custom-built, it required six months to machine and assemble. Its destination is Milano, Italy, where it will carry power to a Mesta 110-in., four-high reversing plate mill. Industrial couplings are used between electric motors and the equipment they drive to transmit power and, at the same time, compensate for the inability to get and maintain perfect alignment of the drive shafts of the two.

Until the record coupling was built, largest couplings heretofore could transmit as much as 50,000 hp, according to Kopper's announcement. Some idea of the size of the one just completed is shown by the fact that the motor hub had to be machined to fit a shaft 32.5 in. in diameter.

Mercury Seal Service Regulator

A new mercury seal version of its standard 107-1 service regulator has been introduced by Rockwell Mfg. Co. Designed to relieve larger volumes of gas in emergencies, the modified 107-1 is being produced as a result of the revision of many utility safety codes which call for more effective relief devices.



The new regulator, the manufacturer claims, will relieve a greater volume of gas than any other device of its type. For example, a modified 107-1 employing a $\frac{3}{16}$-in. orifice with main valve assembly removed and 85 psi inlet pressure, is said to relieve 2400 cu ft per hr with an outlet pressure build-up of less than 1 psi.

Separate mercury seals adaptable to 107-1, 107-2 and 107-3 service regulators already in service are also available. Dimensions of the new regulator are the same as those of the 107-1 except for the mercury well and vent, which are slightly larger than the inlet chamber and vent of the 107. Requests for further information should be sent to Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.

Profilometer

Micrometrical Mfg. Co. has introduced a line of six Profilometer LE-type Tracers for taking surface roughness measurements in holes as small as $\frac{1}{2}$-in. ID, as deep as 24 in. and from 1 to 75μ in. roughness.

In order to enter small, deep holes, these Tracers have an integral Linkarm or Stiffarm, each available in three standard lengths for measuring to maximum depths of 9 in., 18 in., and 24 in. Tracers with Linkarm are intended for operation by means of a motor-driven Mototrace, but can be used for hand tracing if necessary. Tracers with Stiffarm are intended for manual operation, but can be used with a Mototrace by attaching the Stiffarm to a standard Linkarm. All Tracers can be used with any Profilometer Amplimeter.

Full details and specifications are given in Bulletin LT84, available on request from Micrometrical Mfg. Co., 345 S. Main St., Ann Arbor, Mich.

Dust Collector

The American Air Filter Co., Inc., Louisville, Ky., has announced its Design 4, Type N Roto-Clone dust collector, an improved hydro-static precipitator that separates the dust from the air by means of an S-shaped water curtain. This water curtain is said to be highly effective in collecting most types of process dust.

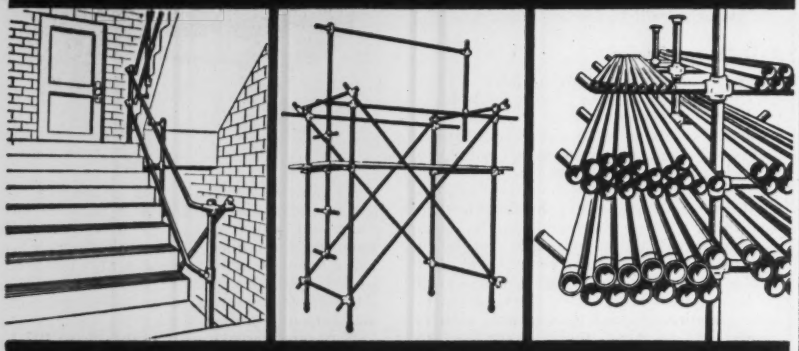
It is available in three basic arrangements which are identical in operating principle but differ in hopper design and means of sludge removal. The three arrangements provide manual cleanout, continuous drain, and sludge ejection by flight conveyors.

Among the advantages claimed are: non-plugging water entrainment separators; heavier sludge ejector mechanism; wider range of sizes and capacities; and sectional construction to permit field conversion from one arrangement to another. The Type N Roto-Clone is made in sizes for capacities from 1000 cfm to 48,000 cfm.

Bulletin 277 will be sent free upon request.

Structural Uses for
ALCOA ALUMINUM PIPE

Quickly, easily assembled with Hollaender Slip-On Fittings of Alcoa Aluminum. Other types of fittings also available.



RAILINGS SCAFFOLDS RACKS

Advantages of Alcoa Aluminum Pipe:

1. **RESISTS CORROSION**—Withstands most contaminated atmospheres without painting.
2. **STRONG**—Has excellent mechanical properties.
3. **LIGHT**—Schedule 40 aluminum weighs *one-third* as much as schedule 40 steel.
4. **ECONOMICAL**—Requires little or no maintenance.
5. **BRIGHT AND CLEAN**—Modern, good-looking appearance.

Most Alcoa distributors and jobbers stock structural pipe and fittings in standard sizes, but Alcoa can supply other sizes to your specifications. Consult your local Alcoa Sales Office or write: ALUMINUM COMPANY OF AMERICA, 903-K Alcoa Bldg., Pittsburgh 19, Pa.

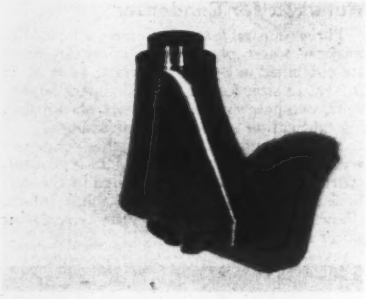
Alcoa Aluminum

ALUMINUM COMPANY OF AMERICA

Three-Dimensional Cams

In the production of three-dimensional cams by the Ford Instrument Co. as many as two thousand data points are end-milled in order to set precisely the contours of hand-cut masters, according to a company statement.

In one group of highly complicated computing mechanisms being built for the Air Force, in which many mechanical and electrical devices process their data through navigational data cams, accurate fabrication is essential. To be certain that all production cams duplicate their masters in every respect, the Ford Instrument Co. designed and built several pantograph-type cam-cutting machines, which can work to ±0.0002-in. tolerance.



Each three-dimensional cam must be able continuously to sustain, without significant yielding or wearing, the live load introduced by a highly pressurized stylus. To meet this requirement, the cams are made of Meehanite, which provides good qualities of machineability, edge-strength, and wear. In addition, they are fabricated to ±0.0005-in. tolerance, and hand-polished to produce a 20-micro-inch surface.

Once taken from their cast, the cams are heated to 1250 F to give stress relief; thermal stresses are subsequently minimized by furnace cooling. Then the ends are rough-sanded and milled, collars turned, and holes drilled.

Two shaping cuts are usually sufficient: the rough cut takes the metal down about 0.125 in., and the finish cut down about 0.010 in. These operations are followed by dimensional inspection, hand-polishing, and another dimensional inspection. Then the cams are rust-proofed by boiling in a ten per cent solution of ammonium hydroxide followed by a baking-out process for 2 hr at 250 F. Surface finish is inspected, blemishes are removed by fine sanding, and final inspection takes place. A light rust-proofing oil is next applied. Before being wrapped and shipped, the cams are given a final coating of heavy oil.

The Ford Instrument Co. is a division of Sperry Corp., 31-10 Thomson Ave., Long Island City 1, New York.

Automatic Heat-Treating Line

An automatic production line 110 ft long is now heat-treating up to 50,000 screws an hour in the hardening room of Standard Pressed Steel Co. of Jenkintown, Pa. The mechanical giant takes Unbrako socket screws for a non-stop 2-hr metallurgical ride through seven separate operations.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

All operations—weighing, first wash, hardening, quench, second wash, tempering, and rustproofing—are timed and tied together by a series of powered belts and shaker conveyors—so that from the time C-bin loads of screws are dropped by fork truck on the weigh scale until the screws are again returned to the C bins after rustproofing at the far end of the line, all handling is completely automatic.

Built around a 30-ft long radiant-tube hardening furnace and a special gas-cracking unit that provides a controlled inert atmosphere for the heat-treating process, the entire line cost SPS close to $200,000. It is part of a $10,000,000 expansion program which in the past three years has modernized and enlarged company facilities for the production of all its major products, Unbrako and Flexloc fasteners, Hallowell steel shop equipment, and the recently acquired Sel-lok spring pin.

On the basis of a week's trial run, Joseph P. Villo, SPS superintendent in charge of form and finish, estimates that the equipment will maintain production at the rate of 1000–1400 lb of screws per hr depending on the size of the fastener being processed. This is about three times the capacity of SPS' largest previous heat-treating line.

The new line was designed and installed by Surface Combustion Corp., Philadelphia, and can heat treat more than half the plant's production of Unbrako standards and specialty aircraft fasteners.

Gear Hobber

Introduction to the American precision machine tool market of the improved Gauthier Precision Gear Hobber, Model W-1, has been announced by Eric R. Bachmann Co., machine tool import company, of 27-11 41st Ave., Long Island City, N. Y. Special design and layout permits economical production of small quantities of spur wheels, pinions, and segments and quick changeover to large quantity production at high speeds with minimum initial tooling costs, according to the company.

Advantages claimed for the machine are: extremely modern design; built-in accuracy which is maintained during years of service; a worm-drive backlash-eliminating device; and consistent operation on a concentricity of 0.00008 in. without difficulty.

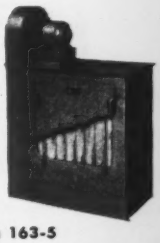
The range of the machine is from $^1/_{16}$-in. to $2^3/_8$-in. outside diameter. The maximum gear width to be hobbed on this machine is $1^9/_{16}$ in. The machine can cut gears with any number of teeth between 6 and 230 and with diametral pitch from 32 down to 170. Besides spur gears and pinions a special attachment is available for the plunge hobbing of worm wheels.

The machine is available in four basic set-ups: (a) manual chucking of gears and pinions with full automatic hobbing cycle; (b) batch hobbing of narrow gears with deburring attachment; (c) plunge hobbing of narrow gears and worm wheels; and (d) automatic magazine feed of pinions and shafts with continuous fully automatic operation. The Model W-1 takes standard hobs of 0.315-in. bore and approximately 1-in. diameter. A longitudinal adjustment which can be controlled on a graduated scale permits usage of the full face of the hob. A special collet chucking spindle is available for small diameter hobs with shank.

The headstock and tailstock feature a collet and drawbar arrangement. Solid

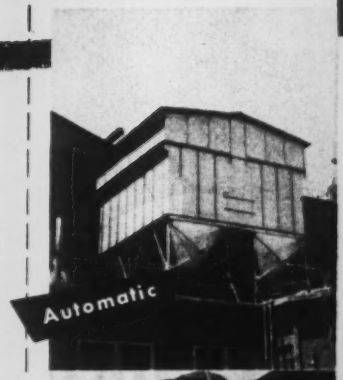
Buy Guaranteed Efficiency in your Dust Collection... Consult Norblo

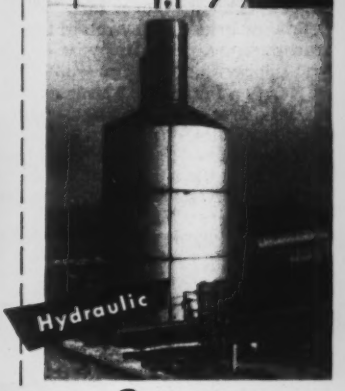
Guaranteed efficiency of fume and dust collection systems engineered and built by Norblo is obtainable because Norblo Equipment includes automatic bag type, improved centrifugal, and hydraulic types. Your operations may require one of these types — or all three! Norblo can tell you — will engineer the necessary combination to handle your dust and fume collection at most economical cost. More than 40 years experience serving many industries. State your problem so we can send literature on equipment applicable to your needs.



Norblo *Portable* Dust Collecting Units solve many localized problems.

Ask for Bulletin 163-5





The Northern Blower Company
Engineered Dust Collection Systems for All Industries
6421 Barberton Ave. OLympic 1-1300 Cleveland 3, Ohio

You have to expect some erasures here and there on your drawings. But watch out! When those drawings get to the blueprint stage, lines can become weak and washed out . . . just *ghosts* of their former selves.

That's why Arkwright Tracing Cloth is preferred by so many architects, engineers and draftsmen. Arkwright is especially treated to take all the erasing you'll normally ever give it . . . and still provide good, clear blueprints.

Arkwright supplies a perfect working surface . . . free of heavy threads, pinholes and other imperfections. And Arkwright defies old age, too. Edges never get ragged; drawings never turn yellow or brittle. They retain their transparency, year after year — giving you the permanency you want.

Here's a fair offer. At our expense, accept a free sample of Arkwright Tracing Cloth. Work with it. See if you don't agree that Arkwright has well-earned the title "America's Standard". Arkwright Finishing Co., Industrial Trust Building, Providence, R. I.

ARKWRIGHT
Tracing Cloths
AMERICA'S STANDARD FOR OVER 32 YEARS

female driving centers, male centers, and special chucking arbors are available to chuck properly any shape of gear. An automatic ejector which is cam-operated can also be attached to the headstock.

Eight hobbing-speeds are available from 500–2500 rpm. A full set of feed change gears is supplied with the machine allowing feeds from 0.0004 in. to 0.08 in. per rev. As standard equipment change gears are supplied with the machine for the hobbing of gears with the following numbers of teeth: 6, 8, 10, 12, 16, 20, 24, 32, 40, and 48. A hand crank permits hand cycling for setting up and incorporates at the same time the clutch to activate the automatic feed. A trip lever switch shuts off the machine after completion of an automatic cycle. The hob cuts from underneath the work piece and drops down and into its starting position prior to shutting off. The machine has a built-in coolant pump. Price is below $2,000 for FOB New York pier delivery. The machine can now be supplied within three months. Parts and service are available from Long Island City.

The Eric R. Bachmann Co., which has the sole distributorship of the Gauthier machines for the United States, states that it is a charter member of the American Assn. of Machinery Importers and is bound to guarantee fully its machines, to maintain spare parts, and to render service.

Packaged Water-Tube Boiler

A line of pre-assembled, water-tube steam generators, designated Type H, is being produced by The Bigelow Co., New Haven, Conn.

The new unit is available in ten standard sizes ranging in capacity from 8000 to 30,000 lb of steam per hr. The complete unit package includes drums, tubes, refractory, steel casing, burner, controls, automatic safety detectors, and soot blowers. It is shipped ready to operate as soon as service connections are made. The heavy steel base functions as a skid for erection and as a support after boiler is in place. No special foundations are required.

The boiler is a two-drum design with a vertical bent-tube arrangement and a water-cooled furnace. Water tubes line the full length of the combustion chamber. The Type H boiler is fired by oil or gas. The unit is adaptable to outdoor service. Free descriptive literature is available on request from The Bigelow Co., New Haven 3, Conn.

Oil-Pressure Reducing Valve

A new oil-pressure reducing and regulating valve, for reducing high pressure to low pressure, has been added to the equipment sold by the Eclipse Fuel Engineering Co., Rockford, Ill., for their series CF closed-flame gas-oil burners. This valve is a single-seated, spring-loaded, direct-acting diaphragm type. It automatically reduces high pressure to low pressure and maintains the low pressure regardless of fluctuations on the high pressure side, the company states.

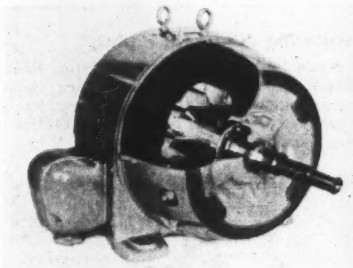
Eclipse claims that any restriction forces the valve wide open with a self-cleaning effect of the seat. The valve has a built-in strainer. The valve has a large bottom plug for inspection and cleaning of parts, and through which worn parts can be replaced. More information can be had by writing to the Eclipse Fuel Engineering Co., Rockford, Ill.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Close-Coupled Pump Motor

Close-coupled pump motors are now available as high as 60 hp through a development of U. S. Electrical Motors, Inc. Designed specifically for use with centrifugal pumps, this motor, type SCB, is claimed to eliminate shaft alignment or pump mounting problems by supporting the pump on its NEMA style "C" registered mounting bracket. A step shaft, with special diameter, shoulder, and tapped hole for mounting the impeller, has all ground diameters for precision assembly and sealing against leakage.



Grease-lubricated ball bearings permit vertical, horizontal, or any intermediate angle installation. Bearings are ample to carry the thrust of centrifugal pumps, according to the manufacturer. U. S. type SCB pump motors have such additional features as asbestos-protected windings, Lubriflush lubrication of bearings, and normalized castings. Further details are obtainable from U. S. Electrical Motors, Inc., Box 2058, Terminal Annex, Los Angeles 54, Cal.

Miniature Bearings in Radar Antenna Rotator

A need for extremely low frictional torque at gear speeds of 1065 and 1200 rpm and very small available mounting space limited by fixed physical dimensions have prompted specification of miniature radial ball bearings at a critical point in a radar antenna rotator designed by Bendix Radio and manufactured by the Akeley Camera & Instrument Corp., according to an announcement by Miniature Precision Bearings, Inc., Keene, N.H.

Frictional torque must be low, the company explains, because a torque output of only 10 in.-oz. obtained at the shaft of the motor which turns the antenna, is required to drive the antenna, a gear train operating a timing cam, and a resolver. Small housing dimensions and a gear arrangement designed to produce an overall reduction of 480:1 require precision bearings that will fit a pinion with a pitch diameter of 0.5625 in.

The resolver transmits the instantaneous orientation of the antenna by following the angular position of the motor shaft with minimum backlash in connecting gears. To reduce frictional loss and prevent excessive radial play and tilting of the gears, a pair of miniature bearings are installed on a fixed shaft on which two concentric gears connecting the motor and resolver shafts are mounted.

The pitch diameter of the larger of the two concentric gears is limited to $2^{1}/_{4}$ in. by the housing dimensions. The 4:1 gear ratio

Ready for you after 12 months of brutal

CUSTOMER TESTING!

CLARK's

New and Exclusive

HYDRATORK DRIVE*

Here's how it improves your fork-truck operation:

1 **MORE WORK:** faster get-away, positive power without slippage; moves heavy loads and climbs ramps with ease.

2 **LOWER COST:** higher percentage of "on-the-job" time results from no clutch problems, "cushioning" effect on motor and drive members.

3 **GREATER SAFETY:** hydraulic brake system, linked to torque converter, automatically cuts power; engine cannot be started unless controls are in neutral.

4 **IMPROVES DRIVER EFFICIENCY:** finger-tip direction control and elimination of gear-shifting conserves operator energy.

Not one, but *eighteen* HYDRATORK-equipped trucks were placed in customers' plants for a full year of on-the-job testing. Without exception, these units proved that reduction in driver fatigue and of truck downtime results in greater production from HYDRATORK-equipped trucks.

1903 1953 CLARK EQUIPMENT

* *Now available in 6-7000 lb. capacity truck*

Mail the coupon for detailed literature which explains how CLARK's new and exclusive HYDRATORK DRIVE operates.

CLARK ELECTRIC, GAS, DIESEL, L P GAS FORK TRUCKS
AND POWERED HAND TRUCKS · INDUSTRIAL TOWING TRACTORS

INDUSTRIAL TRUCK DIVISION • CLARK EQUIPMENT COMPANY • BATTLE CREEK 88, MICHIGAN
Please send: ☐ Hydratork literature ☐ Condensed catalog
☐ Have representative call

Name_____
Firm Name_____
Street_____
City_____ Zone____ State_____

AUTHORIZED CLARK INDUSTRIAL TRUCK PARTS AND SERVICE STATIONS IN STRATEGIC LOCATIONS

...and ANOTHER FINE HEAT EXCHANGER

One of two 44" x 18' fixed tube sheet Heat Exchangers; Stainless Steel Type 316 Shell and Tubes; Carbon Steel Heads.

ON ITS WAY TOWARD CUSTOMER SATISFACTION

. . . Yes, DOWNINGTOWN solicits your inquiry for Heat Transfer Equipment fabricated of Aluminum, Inconel, Nickel, Phosphor and Aluminum Bronze, Copper, Stainless, Monel, Silicon Bronze and various grades of Carbon Steel. Design and construction will meet requirements of A.S.M.E. Code or other agency specified by customer. Equipment of our design is sold on a guaranteed performance basis or we will fabricate to customer's drawings. Modern facilities available for radiographing, stress relieving and heat treating, where required.

Remember: "Your Needs are Our Specialty!" DOWNINGTOWN is experienced in building equipment with Bi-metallic, Finned Tube and Karbate Graphite.

Write on your letterhead for DOWNINGTOWN literature on shell and tube heat exchangers.

DOWNINGTOWN IRON WORKS INC

DOWNINGTOWN IRON WORKS, INC.
DOWNINGTOWN-PENNA.
DIVISION OF PRESSED STEEL TANK COMPANY
Hackney

STEEL AND ALLOY PLATE FABRICATION AND HEAT EXCHANGERS

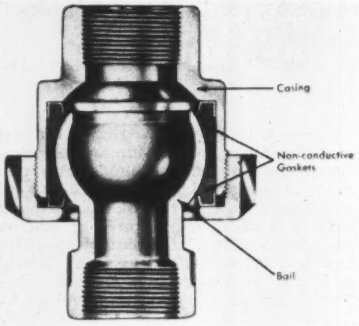
KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

required of the two gears in which ball bearings are mounted establishes pitch diameter of the smaller gear. Gear cutting tool clearance, necessary in manufacturing, limits the diameter of the small gears hub to $^{18}/_{32}$ in.

Miniature bearings with an OD of 0.3125 in. and a bore of 0.1250 in. were selected in order to fit the 0.5625-in. smaller gear with proper cutting-tool clearance and wall thickness. The two bearings are installed with snug slip fits on both the bore and outside diameter and are secured between a shoulder on the housing and a shoulder nut screwed onto the shaft. Like all other moving components of the mechanism, the bearings are lubricated with low-temperature grease.

Insulating Joints for Piping

A new bulletin describing insulating joints for piping lines to electrolytic plating, cleaning, and anodizing tanks used by metal working industries has just been released by Barco Mfg. Co., Barrington, Ill.



As shown, the Barco Insulating Joint consists of a threaded malleable-iron ball end supported between two non-conductive, O-type molded gaskets housed in a threaded malleable-iron casing. Flow is straight through. In a dry condition these joints have a resistance of approximately 100,000,000 ohms. When used with water, resistance through the connection depends on the pH acidity of the water. For a single joint, used with steam, 50–60 v is recommended by the manufacturer as a safe maximum. For higher voltages, two or more joints can be series connected.

These joints are available for pipe sizes ranging from $^1/_4$ in. to 6 in. in malleable iron, with threaded ends as standard, suitable for temperatures up to 425 F and pressures to 300 psi (steam), or as high as 2000 psi (hydraulic) in the smaller sizes. Joints can also be furnished in steel and alloys, and in 4-in. and 6-in. sizes, flanged.

Complete information may be obtained by addressing Barco Mfg. Co., Dept. J-12, 500 Hough St., Barrington, Ill., with a request for Bulletin No. 223.

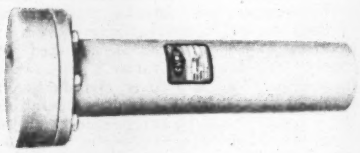
Use a CLASSIFIED ADVERTISEMENT
for Quick Results

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

High-Pressure Filter

High-pressure liquid and gas filters, manufactured in series 1H and 1HG respectively, have been added to the line of Micro-Klean filters made by Cuno Engineering Corp., Meriden, Conn. Standard units are available for operating pressures up to 1000 psi. Filters designed for higher pressures are available upon request. Construction is all welded steel with the head piece machined from bar stock. Pipe sizes for inlet and outlet connections are $^3/_8$ in., $^1/_2$ in., and $^3/_4$ in.



Guaranteed degrees of filtration through the Micro-Klean cartridges are 10, 25, 50, and 75 microns (0.000394 in. to 0.0029 in.). Maximum capacity for liquid at 150 ssu, 2-psi pressure drop, and 50-micron degree of filtration is 15 gpm. For gases at 1000 psig, 2-psi pressure drop, and 25-micron degree of filtration maximum capacity is 200 scfm (free air).

Automatic Lubricating System

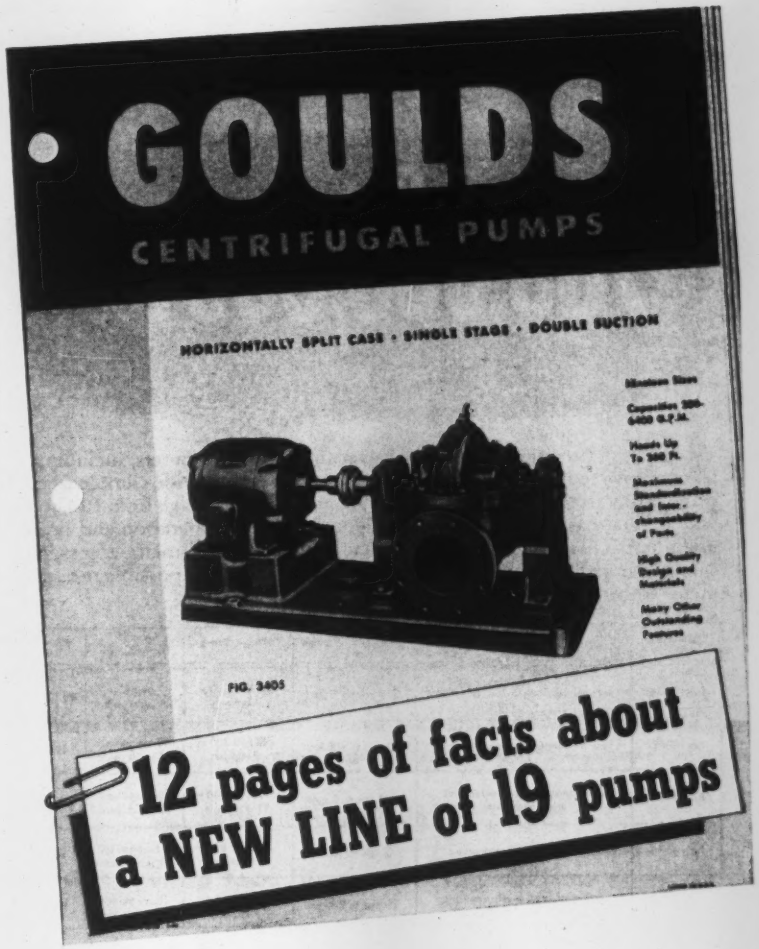
Nathan Mfg. Corp., 416 East 106th St., New York 29, N. Y., has developed an automatic precision lubrication system called the Lo-Flo Lubricator claimed capable of delivering minute quantities of lubricant to as many as 36 individual points, regardless of the difference in pressures required. It is available in 18- or 36-feed models, with or without group regulation of feeds.

The Nathan Lo-Flo Lubricator has a flow rate per feed ranging from 2.3 cu in. per hr to less than 1 cu in. per 700 hr, and can use a variety of lubricants from light oils to light grease at 60 F. Outlets can be manifolded internally to increase flow to selected bearings and the unit can be used with separate or integral reservoir.

The Lo-Flo is available with a number of drives including rotary shaft, built-in ratchet, solenoid, and pressure pulsation of liquids or gases, all provided in several gear ratios. For larger systems a number of remotely located lubricators can be driven and supplied from a central station. Working pressure is 500 psi; relief pressure, 1000 psi.

Open-Hearth-Furnace Controller

Automatic reversal of open-hearth furnaces is now being accomplished by a multiple-record electronic instrument made by The Foxboro Co., Foxboro, Mass. The instrument, a Multi-Record Dynalog Recorder with specially designed Rotax electric control features, uses temperature measurements, by thermocouple or radiation units, as the basis for furnace reversal. The use of a circular chart, with each record in a different color, facilitates a daily check on operating conditions. Additional records of stack and steam temperatures, up to a total of six records, can be provided on the same chart. Bull's-eye lights can be mounted on the instrument or the panel to indicate direction of firing.


GOULDS
CENTRIFUGAL PUMPS
HORIZONTALLY SPLIT CASE • SINGLE STAGE • DOUBLE SUCTION
FIG. 3405
12 pages of facts about
a NEW LINE of 19 pumps

The quickest way you can really discover what the new Goulds Fig. 3405 centrifugal pump can do for you is to read the descriptive bulletin pictured above.

Here are some hints of what you'll find:

The quality of materials and extras of design that you have been able to get only by paying extra are *standard* on this new pump: stuffing box bushings, stainless steel impeller keys, Teflon water seal rings —to mention a few.

The Fig. 3405 carries interchangeability of parts far beyond anything we've been able to do before. Only three shaft and rotating parts assemblies (exclusive of impellers and wearing rings) provide for 19 pump sizes.

This means real spare parts inventory savings for any plant that uses many pumps. It also means easy-to-make field changes to meet new requirements.

We've come as close as modern design and materials allow to putting into this new pump what our industrial customers have told us they want. The 12-page illustrated bulletin tells you all about it. We'll be glad to send you a copy.

To get a copy of Bulletin 721.6, get in touch with the nearest Goulds representative or just fill in the coupon, pin it to your letterhead and mail it to us at your convenience.

Goulds PUMPS INC. Seneca Falls New York

GOULDS PUMPS, INC.
Dept. ME, Seneca Falls, N. Y.

Please send me 12-page information Bulletin No. 721.6 on the new Fig. 3405 centrifugal pump.

Name_____

Company_____

Street_____

City_____ Zone____ State____

Fast, accurate voltage measurements

2 to 700,000,000 cps

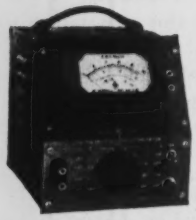
-hp- offers 5 precision, quality-built vacuum tube voltmeters, including a battery-powered model. Together, these instruments provide complete coverage of any frequency from 2 cps to 700 mc, and any voltage from 100 μv to 300 v. Each has high sensitivity, wide range, simple operation and broad usefulness—plus traditional *-hp-* dependability. *-hp-* voltmeter accessories (not illustrated) extend voltage ranges to 30 kv, and make possible measurements from 1 μa to 3 amperes.

Instrument	Primary Uses	Frequency Range	Voltage Range	Input Impedance	Price
-hp- 400A	General purpose ac measurements	10 cps to 1 mc	.005 to 300 v 9 ranges	1 megohm 24 $\mu\mu$fd shunt	$185.00
-hp- 400B	Low frequency ac measurements	2 cps to 100 kc	.005 to 300 v 9 ranges	10 megohms 24 $\mu\mu$fd shunt	195.00
-hp- 400C	Wide range ac measurements. High sensitivity	20 cps to 2 mc	.0001 to 300 v 12 ranges	10 megohms 15 $\mu\mu$fd shunt	200.00
-hp- 404A	Portable, battery operated	2 cps to 50 kc	.0005 to 300 v 11 ranges	10 megohms 20 $\mu\mu$fd shunt	185.00
-hp- 410B	Audio, rf, VHF measurements; dc voltages; resistances	20 cps to 700 mc	.1 to 300 v 7 ranges	10 megohms 1.5 $\mu\mu$fd shunt	245.00

-hp- Voltmeter Accessories include voltage dividers, connectors, shunts and multipliers. Write for details or see your -hp- sales representative.

-hp- 410B Vacuum Tube Voltmeter

Very wide range general purpose voltmeter for all audio, rf and VHF voltage measurements. May also be used as a high impedance dc voltmeter, and as an ohmmeter. Outstanding features include high input impedance, flat response and high shunt resistance which prevents disturbance to circuits under test. Compact, lightweight, easy to operate.



-hp- 400C Vacuum Tube Voltmeter

For high sensitivity audio, supersonic, carrier, telemetering and low rf frequency measurements to 2 mc. Full scale sensitivity 1 millivolt. 10 megohm input impedance insures minimum loading of circuit under test. Linear voltage and db scale.

Data subject to change without notice. Prices f.o.b. factory.

WRITE TODAY FOR COMPLETE INFORMATION

HEWLETT-PACKARD COMPANY
2706L PAGE MILL ROAD, PALO ALTO, CALIF., U.S.A.
SALES REPRESENTATIVES IN PRINCIPAL AREAS

INSTRUMENTS FOR COMPLETE COVERAGE

KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

Reversal is initiated by either of two conditions: first, when the temperature difference between the two checkers reaches a pre-set value, or second, when the temperature at either checker reaches a pre-set maximum.

Reversal by temperature difference allows reversal time to be a function of the temperature of the waste gases, thus helping to keep the regenerative system in balance. An external setting knob on the recorder permits the furnace operator to adjust the temperature difference setting when shorter reversal periods are desired toward the end of the heat.

High-temperature reversal provides an override control, operating directly from an electrical contact which is actuated by checker chamber temperature. This safety feature prevents a checker chamber from reaching an undesirable high temperature, the reversal occurring independently of the temperature difference between the two chambers. Warning alarms can be furnished to alert the operator.

A timing reversal system can also be interwired so that automatic reversal can be actuated by the pre-set temperature difference, elapsed time, or high temperature, whichever occurs first, according to Foxboro. Complete information is furnished in Bulletin AED 330-12 available on request.

Power Thread Gaging Unit

The Taft-Peirce Mfg. Co., Woonsocket, R. I., has announced a companion model to its original Rotochek Power Thread Gaging Unit. Like the Flexible Shaft Model, the new Bench Model Rotochek is an electrically operated gage for checking internal threads by power instead of by manual rotation. The Bench Model has the gaging assembly mounted directly on the motor unit, and is especially designed for bench inspection of threaded products.

Work is brought to the unit, where a slight forward pressure causes the gaging member to screw into the part automatically at the rate of 4 rps. Reversal of applied pressure causes immediate disengagement or reversal of the drive, as desired. Torque control is provided by the clutch design, in order to eliminate any danger of damaging the parts inspected.

The standard spindle will accommodate AGD tapers No. 00, No. 0, No. 1, and No. 2, covering a range of thread gages up to 0.510-in. nominal diameter. A slightly larger spindle assembly can be furnished to extend this range to include AGD No. 3 tapers. Special adapters are also available for reversible thread plug members, and for adapting the Rotochek to inspection of externally threaded parts.

Recording Turbidimeter

A new recording turbidimeter which continuously and automatically measures and permanently records the number of particles suspended in liquids has been announced by the General Electric Co.'s Special Products Section.

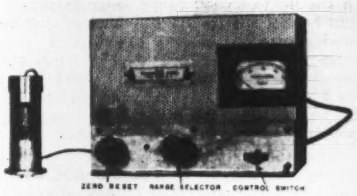
Developed by the company's General Engineering Laboratory for use in any process where turbidity is a significant factor, the GE device can be used with an audible or visible alarm. It provides turbidity measurements for monitoring and controlling. Adjustable over a wide turbidity range, the turbidimeter has a splash-proof construction and semi-null-balance system.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

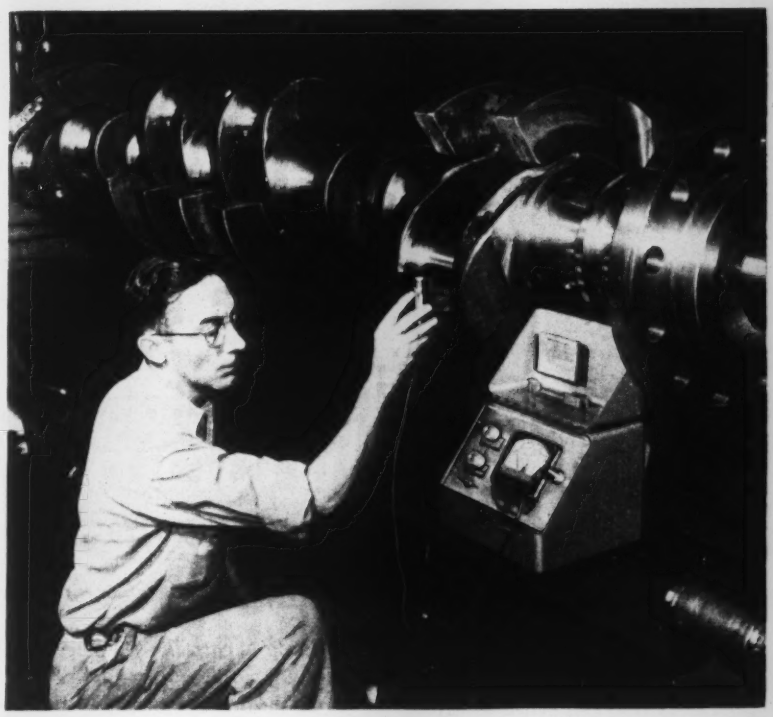
With maximum operating pressure of 100 psi inside the sampling head, the GE recording turbidimeter has an accuracy of plus or minus 5 per cent of full scale and a precision plus or minus 3 per cent of full scale. Range is adjustable in the field from 0–25 to 0–10,000 ppm (silica scale). The sampling head requires 175 w, 115 v a-c, and the recorder needs 55 w at 115 v a-c. Cycle-time is 60 sec.

Photo-Responsive Relays & Meters



Techniflex Corp., Port Jervis, N. Y., has announced the development of a line of industrial photo-relays and photometers for a variety of laboratory research and industrial control duties. The photometers are available in models specifically recommended for the following services: measurement of solution concentration by the monochromatic light method; film densitometry testing; ultraviolet radiation intensity measurements, gas analysis and gas detection by the ultraviolet absorption method; lighting intensity comparison measurements; flash intensity measurements; dust, soot, and smoke intensity measurements; flash duration and light exposure timing measurements; color-matching and opaqueness measurements; liquid turbidometry testing; motor rotary machine speed testing (high-sensitivity tachometer duty); high temperature measurements by the glow color method; and counting measurements. The photo-relays are available in models specifically designed for the following applications: timing control; response to specific machine speeds; dust, soot and smoke control; turbidity control and alarm work; exposure control in X-ray, ultraviolet, infrared, and other related work; safety alarm in danger areas; temperature control; control and alarm duty in connection with solution concentration; control and alarm duty in detecting gases or analyzing gas mixtures; glow temperature control; counting control; color-matching control; camera control in registering sparking and periodic flashing; and camera aiming control.

Photometer Model PM-I-4, shown in the photograph, is said by the manufacturer to be typical of the Techniflex photometers. Specialized for the measurement of radiation from glowing filament sources, it offers four ranges of measurement: 0–0.001 lumen; 0–0.01 lumen; 0–0.1 lumen; and 0–1.0 lumen. In addition to the range selection of the instrument, Techniflex claims its "zero-reset" feature may be used to cancel "dark current" effects and sustained tube noise, thereby isolating the meter reading to incident radiation only; and when particular interest is attached to different measurements, the scope of reset which this control commands may be used to zero a given radiation level with all departures from this level thereafter being registered as a needle swing on a scale of suitable sensitivity. The



Manufactured under patent license from General Motors Corporation.

NEW... the BRUSH SURFINDICATOR*

a practical shop tool for measuring surface roughness

With this new, portable inspection tool you can make surface roughness measurements on the production line. The operator merely guides the pickup over the piece to be inspected and then reads surface roughness in average microinches on the meter.

The SURFINDICATOR is always reliable because the unit is equipped with a set of Precision Reference Specimens. These permit checking accuracy of the instrument at any time and provide a set of standards for absolute calibration. Using SURFINDICATORS, several plants in different locations can all produce parts to the same surface roughness specifications. Get the complete story on the SURFINDICATOR now!

*Trade Mark

BRUSH ELECTRONICS COMPANY

BRUSH ELECTRONICS

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZO-ELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT
ULTRASONIC EQUIPMENT

formerly
The Brush Development Co.
Brush Electronics Company
is an operating unit of
Clevite Corporation.

WRITE FOR FREE BULLETIN

BRUSH ELECTRONICS COMPANY, DEPT. P-10.
3405 PERKINS AVENUE • CLEVELAND 14, OHIO
Please send bulletin on the Surfindicator.
Name _____
Company _____
Title _____
Address _____
City _____ *State* _____

"Engineers Rate the COPYFLEX 93 as the Top Whiteprinter..."

says *Dana H. Bennett*
Bruning Drafting Room Specialist

"Yes, wherever I've sold a COPYFLEX 93 – and I've sold plenty of them—engineers and draftsmen tell me there's nothing like it for speeding prints.

"They find it the finest heavy-volume whiteprinter available. And they like its continuous high-speed production of top quality, dry, ready-to-use prints from either sheets or roll stock. Its vacuum feed permits easy insertion of curled originals.

"On top of this, the '93' needs no expensive ventilation or plumbing."

From prints to pencils, Bruning-trained men like Mr. Bennett can fill every drafting requirement.

You receive "in-person" attention to your needs and fast service on all kinds of drafting room equipment to help you turn out better work in less time at lower cost. Send coupon today for more facts and figures on Copyflex.

From Pencil to Print, only BRUNING has everything

COPYFLEX Whiteprinters
Drafting Machines
Tracing Papers and Cloths
Surveying Equipment
Drafting Furniture
Drawing Instruments
Sensitized Papers, Cloths, Films
Electric Erasers
Complete Line of Drafting Supplies and Equipment

MODEL 93 COPYFLEX

B-3-4

BRUNING

Everything for the Engineer and Draftsman

CHARLES BRUNING COMPANY, INC., Dept. H103
4700 Montrose Ave., Chicago 41, Ill.
☐ Please have a Drafting Room Specialist call.
☐ Send me free booklets on COPYFLEX.
☐ Show me COPYFLEX in action (no obligation).

Name.....Title.....
Company.....
Street.....
City.....Zone....State.....

OFFICES IN PRINCIPAL CITIES

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

company also furnishes custom-made special constructions both as to details and general operation characteristics.

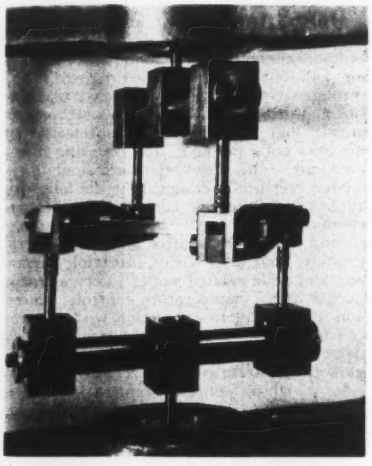
The Techniflex photo-relays are furnished in two standard types, with a single, fixed response level, or with a sharply adjustable response level in each of several selectable sensitivity ranges. All relays offer both normally-closed and normally-open control circuits. "Three-wire" control, with engagement at an adjustable "high" and disengagement at a similarly adjustable "low," is also furnished in the intensity types of relay. Special relay actions inclusive of responses in the micro-second range, latch-in actions, and keying actions are provided as custom-made specials.

Inquiries should be directed to Instruments Div., Techniflex Corp., Port Jervis, N. Y.

Torsion Test Device

To produce pure torsion on a tension testing machine, Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa., has announced the Schaevitz torsion device.

Test specimens up to $^3/_4$ in. square and ranging from 2 to 12 in. long (plus 2 in. to be engaged by torque bars) can be twisted to a maximum angle of 24 deg. Maximum torque load is 60,000 in.-lb, obtained by applying 12,000-lb tension load. The new Schaevitz torsion device is furnished with hardened socket liners for specimens $^3/_8$ in., $^1/_2$ in., $^5/_8$ in., and $^3/_4$ in. square or for round specimens with square ends of these sizes. Other sizes of liners are available on special order.



Ends of test specimens are secured in the centers of two parallel torque bars. Torque bars are rotated in opposite directions by means of four tension members that are pivotally connected in the ends of two equalizer bars. Pivotal connections are provided also for the two spherically-headed tension rods that are seated in wedge block adapters in the testing machine crossheads.

For Consulting Engineers Turn to Page 154

KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Automatic Welding Head

An improved Model 944 automatic welding head has been placed on the market by the Mir-O-Col Alloy Co., 312 North Ave. 21, Los Angles 31, Cal. Control of both welding head and positioner operation is automatic in the 944, as well as the high-frequency pilot circuit, if one is used, the manufacturer declares. The electro-mechanical control circuit is designed to stop both head and positioner automatically if arc is broken or electrode sticks to the work piece. A control cuts off high-frequency unit when arc is established. The motor drive is electrically independent of positioner and welder power supply.

The feed rolls on the welding head are of hardened steel and adjustable for both solid and tube wire and they accommodate any rod size from $\frac{1}{8}$ in. to $\frac{1}{4}$ in. in diameter. Hold-down roll has integral tension arm eliminating springs. The feed nozzle is cast from a special Mir-O-Col alloy; maker's operating tests indicate it will outwear ordinary nozzles 4 to 1. Gear train is ball-bearing equipped throughout with heavy-duty, double-row bearings on feed roll shaft.

The unit is designed to operate with any positioner or transformer; maximum current capacity is 2000 amps. A bulletin describing the 944 automatic welding head and positioner in detail is available upon request to the Mir-O-Col Alloy Co., 312 North Ave. 21, Los Angeles 31, Cal.

Improved Packaged Boiler Design

Continental Boiler Div. of Boiler Engineering & Supply Co., Inc., has reported a simplification and improvement in their boiler construction. The Continental is an automatic steam generator, 20 to 500 hp.

In the Continental Boiler, air for combustion enters the furnace through tangential vanes around the burner register. The register is located in the furnace throat which is surrounded by the heated chamber for returning gas. After travel through the furnace tube, the hot gases are forced through the 3-in. return tubes with a spiraling motion, imparted by a heat-resistant alloy-steel impeller or vane in each tube, to provide maximum heat transfer and low gas temperature at the stack. Under normal operating conditions the stack temperature is guaranteed by the manufacturer not to exceed 125 F above saturated steam temperature at the operating pressure.

RESEARCH ENGINEER

Man to coordinate research program for a large progressive company in the field of propulsion including reciprocating engines, gas turbines, unconventional power plants and propellants. Requires a man interested in research with experience in directing research programs in propulsion or related field.

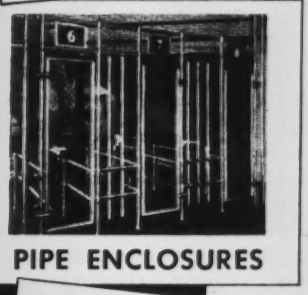
All replies confidential.

Box ME 1260,
221 W. 41 St., N. Y. 36

Structural uses for ALCOA ALUMINUM PIPE

Easily assembled with Nu-Rail Slip-on Fittings of Alcoa Aluminum.*

GUARD RAILINGS



PIPE ENCLOSURES

PROTECTIVE RAILINGS

*Manufactured by Hollaender Manufacturing Company, 3841 Spring Grove Avenue, Cincinnati 23, Ohio

- No threads to cut!
- No welding!
- Time savings on all jobs!

OTHER TYPES OF FITTINGS ALSO AVAILABLE

Advantages of Alcoa Aluminum Pipe:

1. **LOW MAINTENANCE COST**—Withstands most contaminated atmospheres without paint.
2. **GOOD APPEARANCE**—Bright, clean-looking.
3. **STRONG**—Has excellent mechanical properties.
4. **LIGHT**—Weighs $\frac{1}{3}$ as much as steel, size for size.

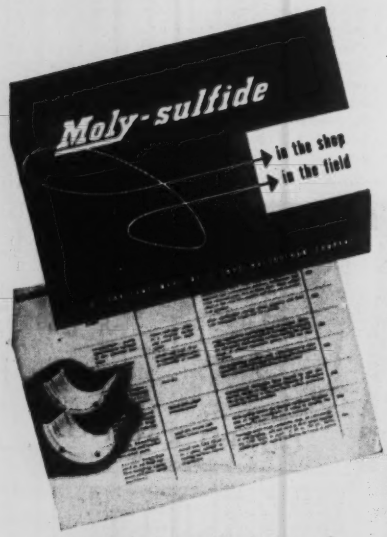
With all these advantages, first cost is moderate. Schedule 10 costs little if any more per foot than Schedule 40 steel.

Alcoa Aluminum

ALUMINUM COMPANY OF AMERICA

Most ALCOA distributors and jobbers stock Schedule 10 and 40 pipe and fittings in standard sizes. ALCOA can supply other sizes to your specifications. Consult your local ALCOA sales office or write: ALUMINUM COMPANY OF AMERICA 903-K Alcoa Building Pittsburgh 19, Pa.

154 ideas on ways to use...



154 varied applications of molybdenum sulfide in the shop and in the field are described in a new booklet now available. This solid-film lubricant has demonstrated unique anti-friction properties under conditions of extreme pressure, high velocity, elevated temperature, or chemical attack.

The 40-page booklet contains the records of solved lubrication problems — some might solve your own.

Moly-sulfide
A LITTLE DOES A LOT

The lubricant for extreme conditions

Climax Molybdenum Company
500 Fifth Avenue
New York City 36 N Y

Please send me your Free Booklet on *Moly-sulfide*
Name.....
Position.....
Company.....
Address.....
MK10

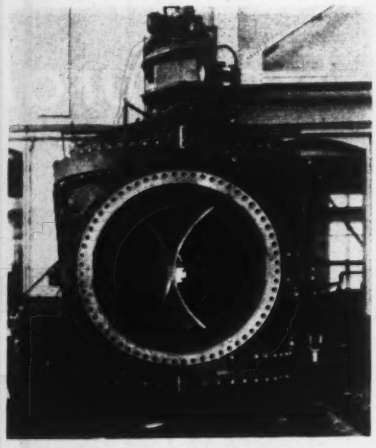
MOLY

MS-6A

KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

Largest Valve

The largest Rotovalve ever made by the company is shown in the shop of the S. Morgan Smith Co., York, Pa. The valve, which measures 84 in. in diameter across the opening and weighs 210,000 lb, is one of three identical valves being manufactured at the Smith shops for the government of Afghanistan through Morrison-Knudsen-Afghanistan. The valves will be installed at Kajaki Dam to control water flow into conduits for a 500,000-acre irrigation project.



Transportation problems for the valves require that they be manufactured so that they can be split for shipment. The valves will travel by water to Karachi, India; they will then be carried by rail through Pakistan to the Afghanistan border. Because there is no available railroad, the valves will be hauled the last 150 mi from the Afghanistan border by truck.

The tunnel clearances on the Pakistan railroad are so low that the body of the valve will be split into four pieces, the head into two, and the plug into two.

Zirconium Strip

An expanded program for the production of zirconium strip and other shapes for atomic energy applications has been announced by Allegheny Ludlum Steel Corp., Pittsburgh 22, Pa. The program is the result of over two years of research and production experience accumulated by the company in melting and shaping zirconium metal. Allegheny Ludlum's work in this field has been carried on as a project in cooperation with the Atomic Energy Commission's Bettis Plant, Pittsburgh, Pa., operated by the Westinghouse Electric Corp.

The usefulness of normal zirconium for atomic reactors is limited by the presence of small amounts of the element hafnium present as a contaminant in the metal. The Oak Ridge National Laboratories of the Atomic Energy Commission developed a method to remove hafnium and it is now possible to obtain sponge which is free from hafnium. The United States Bureau of Mines has been producing this sponge, and melting it into ingot form. Allegheny Ludlum has become the first private organization to go into the melting of this sponge material. Zirconium melting is done at

DESIGN IN STEEL CUTS WEIGHT 48% LOWERS COST 52%

PROPER design in welded steel can cut manufacturing costs an average of 50% on many products. In addition, steel designs are stronger, more rigid, can be fabricated with less material and fewer shop manhours.

The machine arm shown in figure 1 originally required 182 pounds of gray iron and cost $38.25 to cast and machine.

By converting to welded steel construction the arm (Fig.2) can be built for only $20.06 and weighs but 86.8 pounds. Since steel is three times stronger and twice as rigid as gray iron, the wall sections of the steel design are 3/16" plate instead of the original 5/8" dimension. As a result, the weight saving is 48% which is particularly important because of inertia factors on this particular component.

Utilizing standard mill shapes, the rugged steel box-type construction is fabricated at 52% less cost using simple fixtures. Machining and finishing is easier and takes less time, to increase shop efficiency.

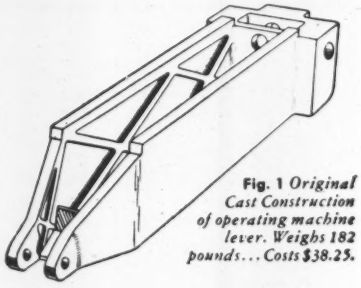


Fig. 1 *Original Cast Construction of operating machine lever. Weighs 182 pounds... Costs $38.25.*

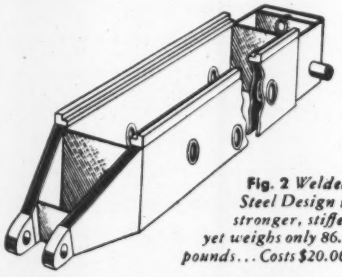


Fig. 2 *Welded Steel Design is stronger, stiffer yet weighs only 86.8 pounds... Costs $20.06.*

HOW TO DESIGN FOR STEEL

Machine Design Bulletins giving latest methods for converting product designs to steel with Lincoln's Weldesign System are available by writing The Lincoln Electric Company, Cleveland 17, Ohio. Write Dept. 4805.

THE LINCOLN ELECTRIC COMPANY
CLEVELAND 17, OHIO
THE WORLD'S LARGEST MANUFACTURER OF ARC WELDING EQUIPMENT

Allegheny Ludlum's Watervliet, N. Y., plant. A double melting procedure involving unique furnaces is employed. The principal melting problem is the maintenance of the high purity of the sponge through the melting processes.

One of the features of zirconium, its very high resistance to acid attack, makes it impossible to clean by the pickling methods normally used in steel production. For this reason, some special measures are used to insure proper scale removal. The company has found that the main difference between converting zirconium and stainless steel is that zirconium requires lower temperatures during hot work. No special safety cautions are necessary. Temperature ranges from 1500 to 1800 F dependent upon the operation.

Most of the company's output is in strip, with some small flats also being produced. Occasional wire orders are also filled. In general, Allegheny Ludlum feels that any product normally produced on steel mill equipment will be possible.

Allegheny Ludlum's current maximum capacity for zirconium melting is of the order of 120,000 pounds per year, and present commitments are expected to use most of that capacity. The company hopes to be fabricating for other customers within the next year, and may increase its melting capacity within that time.

Pencil Slide Rule

A slide-rule pencil has been announced as available to the public and to industry by the Device Development Co. The pocket device writes in two colors, calculates, and magnifies. Among the ten functions which it also combines in one instrument are a collapsing measuring scale, fine-print magnifier, depth gage, detachable ruling edge, concealed eraser and spare leads, plain and enlarging cursor for the slide rule's nine scales (A, B, C, D, L, S, T, CM, and IN), and an optical pocket-clip.

There is a choice of three color styles, white, yellow, or black. The pencil is 6¼ in. long and weighs less than 1 oz. Gift-boxed, the Devco Slide-Pen-Cyl, with an instruction folder on slide rule use, retails at $4.98 at drafting and art supply stores, or from the manufacturer, the Device Development Co., 226 West 4th St., New York 14, N. Y. Special scale, personal, or business imprint variations of the instrument are available.

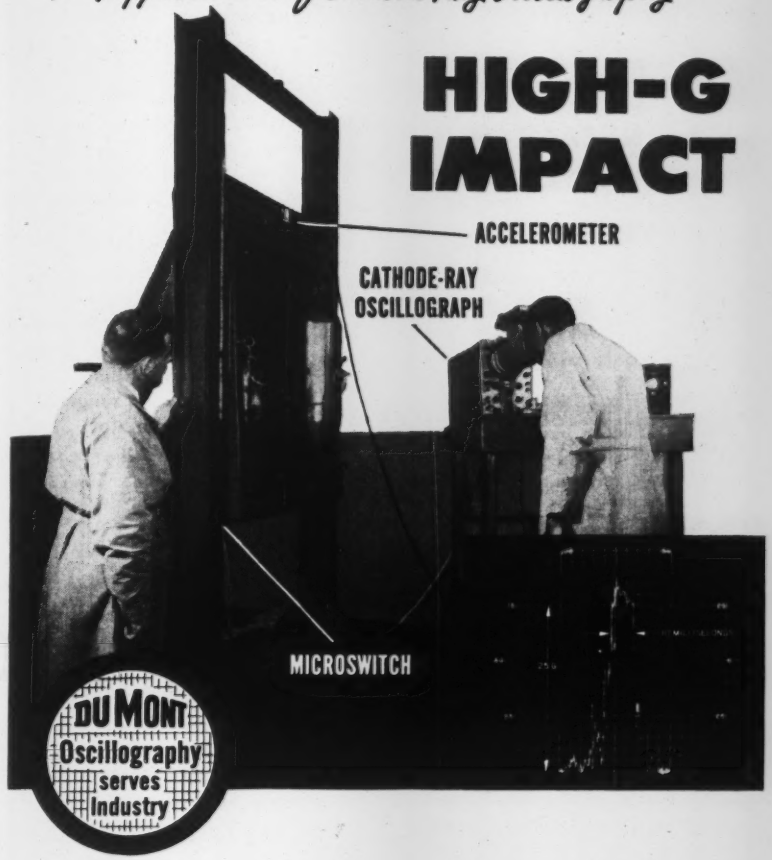
Diesel-Powered Shoveloader

The combination of cheap diesel power with front-end loading up to 5000 lb capacity is featured in the Baker-Lull Shoveloader, mounted on a Sheppard industrial wheel-type tractor, according to Baker-Lull Corp., Minneapolis, Minn.

The manufacturer points out that diesel power will return fuel cost savings up to 75 per cent, compared with the operation of gasoline powered equipment. Other advan-

Applications of cathode-ray oscillography

HIGH-G IMPACT



DU MONT Oscillography serves Industry

The Physical Setup: A bomb-release mechanism holding a dummy bomb is rigidly attached to a metal frame. This assembly can be dropped any preset distance to a solid base bearing a damping material.

The Problem: To measure the deceleration of the mechanism and to prove that it has withstood 25 G for a period of at least 10 milliseconds as required by specifications.

The Solution: A cathode-ray oscillograph* and oscillograph-record camera** are used to record the waveform of deceleration vs. time.

An electrical signal, proportional to deceleration is obtained from a strain-gage-type accelerometer and applied to the Y-axis of the cathode-ray oscillograph. The accelerometer is rated in millivolts per G per d-c volt applied. In this application 750 millivolts corresponds to an acceleration of 25 G for the test conditions set up. The screen of the cathode-ray oscillograph has been calibrated for 1000 millivolts full scale. Therefore, 75 on the scale equals 25 G.

The time axis is an externally-triggered sweep, generated within the cathode-ray oscillograph. The time axis is calibrated by applying the 60-cycle calibrating wave, generated within the cathode-ray oscillograph, to the sweep and adjusting the sweep so that one cycle occupies 3 divisions of the scale. This makes each scale division along the sweep equal to 5 milliseconds. The oscillograph sweep is triggered by a d-c voltage suddenly applied to the external sync post by a microswitch which is tripped by the descending metal frame just before the impact point. A capacitor across the microswitch prevents arcing from getting into the signal leads.

The oscillogram shows that at 75 on the scale, the width of the pulse is more than 2 divisions or 10 milliseconds, and that the test specifications have been met.

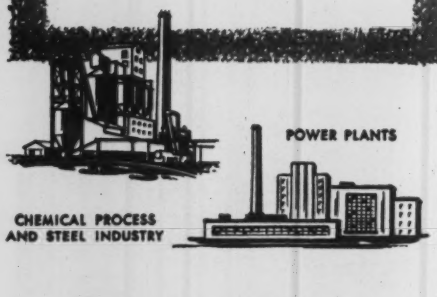
An important application of Du Mont cathode-ray instrumentation by Brown and Mole, Inc., Lindenhurst, Long Island.

*Du Mont Type 304-A
**Du Mont Type 297

DU MONT for Oscillography

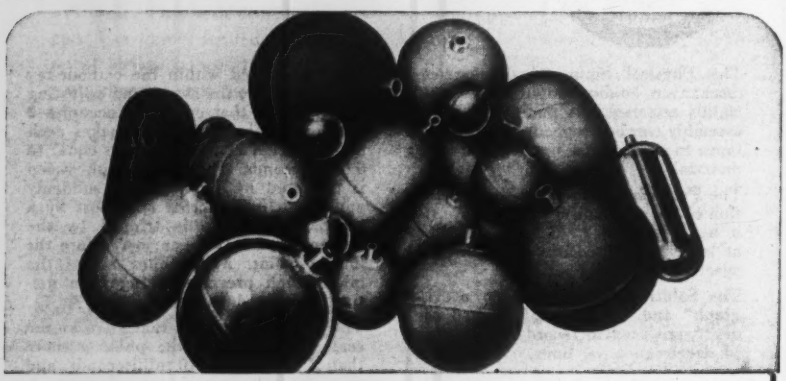
For further information write to:
TECHNICAL SALES DEPARTMENT, ALLEN B. DU MONT LABORATORIES, INC.
760 BLOOMFIELD AVENUE, CLIFTON, NEW JERSEY

Industry looks to
RESEARCH CORPORATION
for high dust collection efficiencies



To maintain visually clean stacks at all times, industry is turning to the long experience of Research Corporation in the design and manufacture of highly efficient Cottrell Electrical Precipitators. We've spent 40 years in solving such problems as nuisance abatement, cleaning gas for subsequent use and recovering materials of value. Write for illustrated bulletin describing a wide range of electrical precipitator applications.

RESEARCH CORPORATION
405 Lexington Ave., New York 17, New York
122 South Michigan Ave., Chicago 3, Illinois
Bound Brook N. J. • *Grant Building, Pittsburgh 19, Pa.*



Send for Nicholson
FLOAT BULLETIN 753

Complete Data on Welded Floats; Diagrams, Tables, Formulae for Calculating Buoyancies

The booklet is a standard reference for specifiers of welded floats. Nicholson furnishes any type for external or internal pressures; in stainless steel, Monel, chromium, cadmium or copper-plated steel. Sizes, 2" to 14" diam., press. to 4800 lbs., standard or special connections. Quick delivery on many sizes and shapes. Nicholson floats are standard with hundreds of manufacturers.

W. H. NICHOLSON & CO.
TRAPS · VALVES · FLOATS
219 OREGON ST., WILKES-BARRE, PA.

KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

tages include extremely low replacement costs, an 8-speed transmission that permits full throttle operation at each job speed, and the design of Sheppard tractors for use in critical conditions of mud, water, and uneven ground.

The Baker-Lull Shoveloader, available with seven materials handling tools, is said by the manufacturer to have 66 per cent more lifting power than comparable units, and a cost-per-pound of 40 cents, compared with 45 cents, 51 cents, and 59 cents of similar equipment. It will crowd and dig below tractor level, lift a 5000-lb capacity load to 10 ft 3 in., dump it at 8 ft 6 in., and reach 5 ft 10 in. ahead of the tractor radiator shield. Lift speed is 12 sec; lowering speed, 9 sec. Special double-acting hydraulic cylinder design enables the operator to shake the materials bucket thoroughly clean, adding to operating efficiency.

The unit is engineered for clear visibility ahead in critical loading or unloading positions, and all actuating parts are located well ahead of the operator for safety, the manufacturer says. Tools available with the Shoveloader include a material bucket, combination coal-and-snow-bucket, bulldozer, lifting crane, sweeper for snow clearance and clean-up, rear leveling blade scarifier, and logging fork.

For literature and price information on the Baker-Lull Diesel-Powered Shoveloader, write Dept. KP, Baker-Lull Corp., 314 W. 90th St., Minneapolis 20, Minn.

Liquid-Level Gage

A new Convex Scale Jerguson Truscale Remote Reading Gage has been announced by Jerguson Gage & Valve Co., 80 Fellsway, Somerville, Mass. The new Convex Scale permits full 180-deg visibility, according to Jerguson.

The new Convex Scale Jerguson Truscale is designed so that readings of the liquid level can be taken from the front, or either side, without distortion. Scale markings are directly on the convex face. Indicator goes clear around the convex surface.

Jerguson Truscales are claimed to give remote readings of liquid levels of boilers, tanks, etc., with the accuracy of 0.5 per cent of scale reading. Compensated manometric gage meets the new interpretation of the boiler code for WSP of 900 psi or higher, the company declares. There are no stuffing boxes. Models are available for any pressure and range. For marine use, special installation procedure compensates for roll and pitch of ship. Light and horn alarm signals, as well as Truscale Repeaters for repeating gage reading at auxiliary points, are available. Further details on request.

Self-Cleaning Dust Collector

Pangborn Corp. Hagerstown, Md., has announced production of the Pangborn type CH-3 Self-Cleaning cloth screen dust collector. The unit permits continuous automatic dust collection, constant air volume and suction, and positive reverse-flow filter cleaning.

The CH-3 collector uses reverse air flow for continuous cleaning of its cloth filters. This is accomplished by action of a traveling manifold whose integral reverse air blowers takes its air directly from the clean air side of the collector.

Standard sizes of the CH-3 Self-Cleaning collector are furnished with six-screen-high construction. Also available for small air

KEEP INFORMED

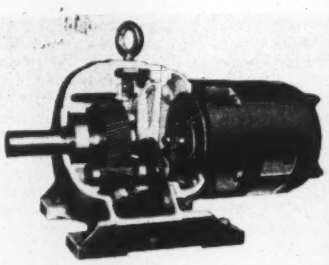
NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

volume problems are four- and five-screen-high by 5-ft long screen sections. Existing installations of Pangborn type CH cloth screen collectors can be converted to the self-cleaning arrangement by removal of the mechanical rapping mechanism, replacement of the grid wall, and slight alterations to the screen frames and clamping devices.

Other features claimed for the Pangborn CH-3 Self-Cleaning collector are: (a) all-steel wire mesh screen frames; (b) screens of convenient size and weight for handling by one man; (c) cloth filter bag of design that can be applied without tension or strain; (d) inherent electrical grounding on screen frames; (e) location of all moving parts of cleaning mechanism on clean air side; and (f) accessibility on both dust and clean sides for inspection.

Gear Motor

Extending its line of gearmotors, Century Electric Co., St. Louis, Mo., has announced the availability of a complete, new integral gearmotor series from 1 to 15 hp. The motors are offered in a range of speeds, in single, double, and triple gear reductions.



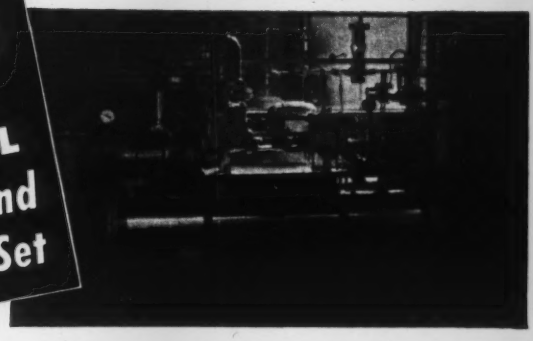
In the new Century gearmotors, gears meeting AGMA Class I, II, and III specifications can be had to fit varying load requirements. Motors are available with constant or variable speeds and with protective frames to operate under most atmospheric conditions. A bulletin containing illustrations, operating data, and application information, can be had from Century Electric Co., 1806 Pine St., St. Louis 3, Mo.

Air Release and Air Inlet Valve

The Type AV Air Release and Vacuum Breaking Valve was designed for the purpose of providing a compact unit having the functions of releasing automatically air accumulations from pipe systems, admitting air to systems for breaking vacuums within these systems, and venting large quantities of air from pipe lines when filling systems with water. Made by the Simplex Valve & Meter Co., 68th & Upland St., Philadelphia 42, Pa., this device combines these three functions, the manufacturer states, and permits the intake and exhaust of air through one valve body. It is designed with a 2-in. threaded inlet opening.

This form of valve is said to have application in a variety of fields and may be used under working pressures up to 150 psi wherever air accumulations are found to pipe lines and where difficulty of flow of water is experienced due to air binding. The value has a maximum diameter of 11½ in. and an overall height of 16¼ in. The weight of each unit is 160 lb.

ENCO
DUAL FUEL-OIL Heating and Pumping Set

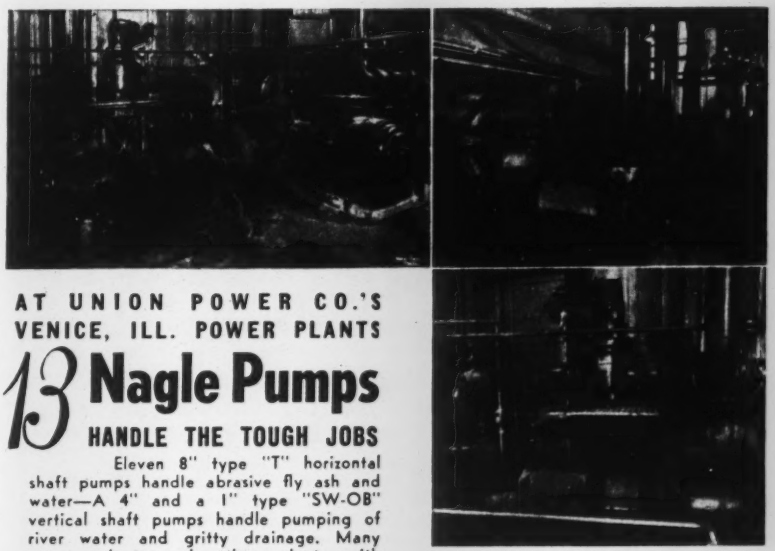


Two heaters and two pumps—one steam, one electric driven—in one set with these six features:

1. Completely automatic operation with temperature and pressure regulation.
2. All essential equipment—including safety valves as needed—in one compact unit.
3. Individually designed to meet the specific needs of the power plant.
4. All parts visible and accessible for easy operation, maintenance and repair.
5. Pumps run at moderate speed. Heaters designed to give the correct viscosity and velocity without fouling.
6. Cleaner boiler room . . . all overflows connected to a common outlet, flanged drip pan for pumps catches oil drip.

EC490

THE ENGINEER COMPANY
75 WEST STREET, NEW YORK 6, N. Y.
IN CANADA: ROCK UTILITIES LTD., 80 JEAN TALON ST. W., MONTREAL, P. Q.



AT UNION POWER CO.'S VENICE, ILL. POWER PLANTS

13 Nagle Pumps HANDLE THE TOUGH JOBS

Eleven 8" type "T" horizontal shaft pumps handle abrasive fly ash and water—A 4" and a 1" type "SW-OB" vertical shaft pumps handle pumping of river water and gritty drainage. Many power plants—and other plants with abusive pumping conditions—have found Nagles both efficient and ultimately economical. Send for "Nagle Pump Selector".

NAGLE PUMPS

NAGLE PUMPS, INC.
1999 CENTER AVENUE, CHICAGO HEIGHTS, ILLINOIS

PUMPS FOR ABRASIVE AND CORROSIVE APPLICATIONS

Sound Films you can use without cost!

SEE how others cut production costs

"MULTIPRESS—Blanking & Forming"

A 10-minute, 16mm sound film . . . close-ups of several production jobs *including the fastest hydraulic press operation you've ever seen!* Ideal for ASME meetings, student groups, production clinics!

Other 16mm Sound Films

"MULTIPRESS—and how you can use it"

30 minutes of Multipress action on broaching, trimming, forming, marking, crimping, assembling, staking and pressing jobs.

"INDEX to Profits"

A 20-minute film showing how Multipress ends lost time and motion with a space-saving 13-step assembly line for 34-piece auto door latches.

Write Denison, or the Denison representative in your area, about the films you'd like to use—and when. *No obligation whatever.*

The DENISON Engineering Co.
1189-A Dublin Rd., Columbus 16, Ohio

NATIONAL AIROIL BURNERS
FUEL OIL - GAS

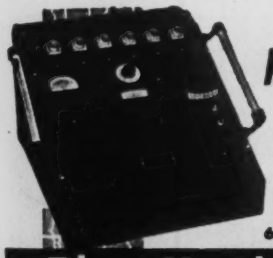
SERVING INDUSTRY FOR 41 YEARS

- Steam Atomizing Oil Burners
- Mechanical Atomizing Oil Burners
- Low Air Pressure Oil Burners
- Rotary Oil Burners
- Industrial Gas Burners
- Combination Gas and Oil Burners
- Tandem Block Combustion Units
- Fuel Oil Pump Sets
- Refractory Burner and Muffle Blocks
- Valves, Strainers, Furnace Windows

Detailed information gladly sent you upon request.

Established 1912 — Incorporated 1917

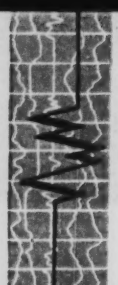
NATIONAL AIROIL BURNER COMPANY, INC.
1239 East Sedgley Ave., Philadelphia 34, Pa.
Southwestern Div: 2512 So. Blvd., Houston 6, Tex.



Measure and Record Strain with PRECISION

6-channel unit

The Hathaway TYPE RS-10 PRECISION STRAIN INDICATOR
6, 12, 25 or 50 Channels



For Precision Measurements of Static Strain

Static strain in 1 to 50 channels can be measured in rapid succession. Individually-calibrated 21-inch dial provides an accuracy of ¼ percent. Smooth and accurate balancing controls for each channel. Continuously-variable gage-factor adjustment.

For Recording Dynamic Strain

The RS-10 can be used with an oscillograph (such as the Hathaway type S14-C) for recording dynamic strain, providing *accurate balancing* and means for *precision calibration of the records.*

MULTI-CHANNEL PRECISION MEASUREMENTS OF STATIC STRAIN
DYNAMIC STRAIN RECORDING TO 300 CPS WITHOUT AMPLIFIERS

Write for Catalog Sheet 3-H-4-N for details.

WRITE FOR YOUR FREE COPY OF HATHAWAY ENGINEERING NEWS

Hathaway INSTRUMENT COMPANY
1315 SO. CLARKSON STREET • DENVER 10, COLORADO

KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

Bearing Calculator

A calculating device which supplies bearing users with information necessary in the selection of ball thrust bearings has been introduced by Aetna Ball & Roller Bearing Co.

Its circular sliding scale provides the user with a means of converting bearing capacities (load, speed, and life) as required for any given application into terms of rated bearing capacities. In effect, Aetna says, it selects the proper bearing size for the application under consideration without the usual, tedious pencil-and-paper calculations.

As a further aid to proper bearing selection the reverse side of the calculator illustrates the company's line of standard ball thrust bearings along with condensed specifications of each.

The calculator is available without charge through distributors and jobbers throughout the country or direct from the main offices of Aetna Ball & Roller Bearing Co., 4600 Schubert Ave., Chicago 39, Ill.

Insulating Coating

A new quick-drying material that can be sprayed like paint on metal and claimed to make the treated surface capable of withstanding temperatures as high as 5000 F has been developed by The B. F. Goodrich Co. Called "Pyrolock," a $^1/_{16}$-in. coating of the insulation protects metal for as long as ten seconds against flame temperatures hotter than the melting point of metals, according to the company.

Pyrolock is described as "a water-base inorganic material unique in the field of thermal insulation," and was developed at the request of the Defense Dept. for use in the rocket and guided-missile field. Laboratory tests conducted over a two-year period indicate that the new material resists higher temperatures for longer periods than any other preparation available for use in that field, BFG reports.

Pyrolock is said to be non-toxic, non-flammable, non-explosive and adherent directly to clean metal surfaces without sandblasting or use of priming surface preparations. Resistant to most solvents and chemicals, the material also withstands indefinitely temperature cycles of −60 F to 165 F, the manufacturer declares.

Pyrolock was invented by Donald V. Sarbach, manager of BFG's general chemical laboratories, and is manufactured by The B. F. Goodrich Co., Industrial Products Div., Akron, Ohio.

Rivet Fastener Selector

A slide-chart calculator, which enables manufacturers of assemblies to select the right fastener for each job quickly and easily, is available from The Milford Rivet & Machine Co., Milford, Conn. The Fastener Selector is $8^1/_2$ in. wide and $5^1/_2$ in. high, lithographed in red and blue on white smooth-finished heavy cardboard, riveted together on a 52S55 Milford Riveting machine.

Tabulated information is given for extruded and drilled tubular rivets, bifurcated (split) rivets, and cutlery rivets. The data include: part catalog numbers, principal and critical dimensions, and information on normal clinch allowances and clearance holes in work. The dimensions given in the calculator are indicative of the best practice, based on user service records, according to the company.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Flow Meter

A new flow meter of the electronic type which makes use of mercury-less bellows transmitters has been announced by The Hays Corp. The meter is available in several different models for indicating, recording, and with a continuous mechanical integrator or combinations thereof for measurement of the flow of fluids such as steam, water, and gases. Records of air flow for boiler operation and pressures and temperatures can be combined in the same meter.

The differential-pressure transmitters used with the meter are of the metallic-bellows, rupture-proof type for differentials of from 20 in. of water to 750 in. of water with a standard static operating pressure of 1500 psig. Higher pressure ratings can be supplied if required. The meter is also available for the measurement of liquid level in an enclosed vessel such as a boiler drum. The transmitter for this application differs from the others in that it is buoyant-float operated with torque tube assembly. The transmission system employed between the transmitter and recorder uses differential transformers and a null-balance a-c system independent of line voltage variations. An electronic amplifier in the circuit of the meter assures maximum sensitivity and a great speed of response, the manufacturer declares. The six-counter integrator is continuous in operation.

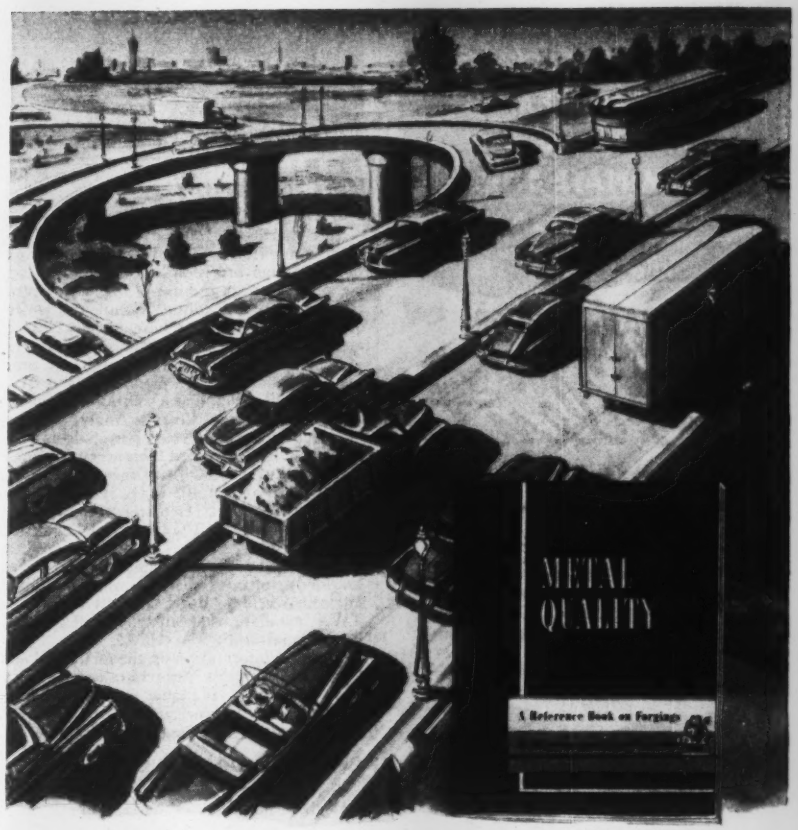
Other advantages claimed include: unaffected by normal voltage, frequency, temperature variations or reasonable length of transmission lines; 3-to-1 range calibration at recorder; high accuracy; 12-in. uniformly graduated charts; no integrator creep at zero; easy micrometer zero adjustment; and indicators can be calibrated to read directly. Further details are available from The Hays Corp., Michigan City, Ind., in introductory bulletin Publication No. 52-1074-222.

FOR A BRIGHTER TOMORROW GIVE TODAY

C P
UNITED CEREBRAL PALSY

YOUR HELP IS THEIR HOPE!

GIVE TO YOUR LOCAL AFFILIATE



Engineering, production and economic advantages obtainable with closed die forgings are presented in this Reference Book on Forgings. Write for a copy.

This Book Reveals the Matchless Capacity of Forgings!

That makes possible Modern Transportation

What a forging *has*—can't be duplicated! No other method of fabricating parts utilizes fully the fiber-like flow line structure of wrought metals. Now is an excellent time to check your product for cost reductions—to explore possibilities for improving performance—to reduce dead weight. Check problem parts with the unrivaled advantages of closed die forgings and the closed die forging process for producing parts. Double-check all parts, particularly those which are subjected to great stress and strain. Then consult a Forging Engineer about the correct combination of mechanical properties which closed die forgings can provide for your product.

DROP FORGING ASSOCIATION

605 HANNA BLDG. • CLEVELAND 15, OHIO

Please send 64-page booklet entitled "Metal Quality—How Hot Working Improves Properties of Metal", 1953 Edition.

Name .....

Position .....

Company .....

Address .....

Get the Facts!

about WATER HAMMER

and how you can

ELIMINATE THIS COSTLY NUISANCE

with

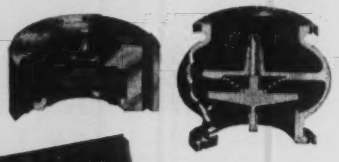
WILLIAMS-HAGER

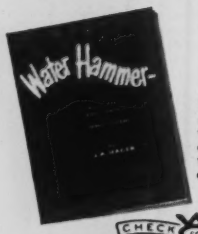
FLANGED

Silent

CHECK VALVES

Yes—you can put an end to costly, dangerous water hammer in your piping system—NOW—with Williams-Hager Flanged Silent Check Valves. Compact and durable, they can be installed without special tools—in any position. Built for years of silent service, they are available in standard pipe sizes from 1" to 20". Investigate today!





WRITE FOR BULLETIN WH-851

This bulletin contains all the facts about water hammer—its cause, effect and control. Write for your copy!

CHECK VALVES

THE WILLIAMS GAUGE CO., INC.

3019 Pennsylvania Ave., Pittsburgh 33, Pa.

MAIL THIS COUPON TODAY

THE WILLIAMS GAUGE CO., INC.
3019 Pennsylvania Avenue
Pittsburgh 33, Pa.

Please send a copy of Bulletin WH-851 on "Water Hammer, Cause, Effect and Control in Piping Systems."

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE___ STATE_____

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Mass Spectrometer Analytical Service

Specialized problems in chemical analysis, process monitoring, isotope-ratio determination, and high-precision leak detection solvable only through the use of mass spectrometer instruments often occur too infrequently to justify purchase of such instruments. Many chemical and petroleum researchers, universities, hospitals, and pressure or vacuum-system manufacturers, faced with this dilemma, find a solution in Consolidated Engineering Corp.'s Analytical Service Dept. Available on a per-analysis basis is a permanently staffed laboratory equipped with the latest CEC instruments, including the 21-103B and 21-401 Mass Spectrometers, the 24-101A Leak Detector, the Spectro-SADIC, and the 30-103 Electrical Computer. All sample runs, analyses, tests, and computations are made by personnel having broad knowledge of both chemical and specialized analytical fields. Both Western Union and TWX installations speed reports of urgently needed analyses.

Detailed information on the analytical and computing services are contained in CEC Bulletin 1813A, available on request from Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Cal.

Belt-Center Distance Calculator

Belt-center selection for fans and compressors, determination of horizontal distances between shaft centers, and checking equipment clearances is aided by the Korfund Belt-Center Distance Calculator developed and offered by the Korfund Co., Inc., Thirty-Second Place, Long Island City, N. Y.

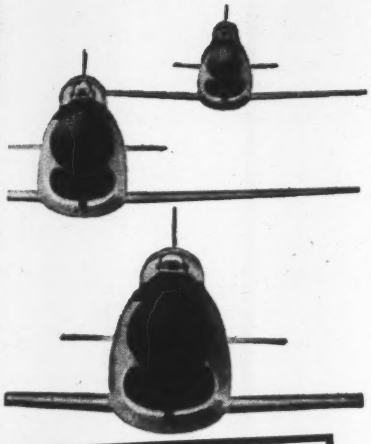
Claimed accurate to $\frac{1}{8}$ in., the calculator is said to replace the calculations previously needed by giving the desired information in graph form. On the reverse side of the $8\frac{1}{2} \times 11$-in. Calculator Sheet is a Fan Engineering Data Sheet giving National Association of Fan Manufacturers and National Electrical Manufacturers Association Data. Also included is standard nomenclature for fan width and an explanation of fan class.

Safety Shutoff Valve

North American Mfg. Co. has recently put into production the solenoid-operated model of its new Series 22 Safety Shutoff Valve. Approved by Factory Mutual, the valve, a globe type, is intended primarily for use in gas or oil lines, and is offered in all standard pipe sizes from $\frac{3}{4}$ in. through 6 in. Valves up to 2-in. size have threaded connections; larger valves are flanged, but companion flanges are offered if threaded connections are desired in the large sizes.

The Series 22 Valve, as shipped from North American, extends $3\frac{7}{8}$ in. on one side of the pipe, and $4\frac{3}{8}$ in. or $5\frac{1}{8}$ in. on the other side, depending on valve size. The mechanism may be rotated relative to the valve body to take advantage of this short dimension in another direction if desirable. The valve may be mounted in a vertical line as well as horizontal, and if mounted overhead out of reach it may be operated with a chain and reset wheel, as optional equipment. The valve mechanism will withstand ambient temperatures as high as 167 F, and oil heated to 250 F may be passed through the valve itself, according to the maker.

Further details may be had from North American Mfg. Co., 4455 East 71st St., Cleveland 5, Ohio, asking for Sheet V-22-1.



Engineers—

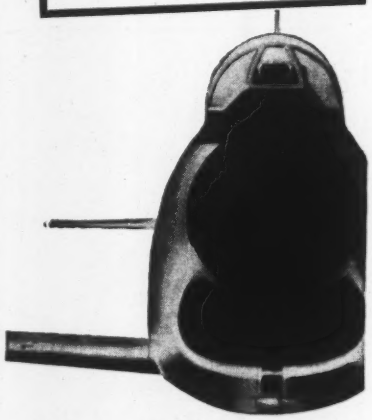
PICK A WINNER

The Engineering Department which designed the **Sabre** and other headline-making military airplanes has openings for engineers—experienced in aircraft, recent engineering grads, or men from other fields with adaptable experience. Long-term military projects and twenty-five years of continuous expansion underwrite your future at North American. Current openings in:

All Design Fields

Thermodynamics | Aerodynamics
System Analysis | Structures
Servo-mechanisms | Electronics
Specialists in all major aircraft fields

Liberal travel and moving allowances



Write to

North American Aviation, Inc.

DEPT. 6, ENGINEERING PERSONNEL OFFICE
LOS ANGELES INTERNATIONAL AIRPORT
LOS ANGELES 45, CALIFORNIA
or
COLUMBUS 16, OHIO

NORTH AMERICAN HAS BUILT MORE AIRPLANES THAN ANY OTHER COMPANY IN THE WORLD

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Motor for Oil Burners

A new fractional-horsepower motor for high- and low-pressure oil burners, smaller and lighter than previous models for this application, has been announced by the General Electric Co.'s Fractional Horsepower Motor Dept.

It is said to be the first standard oil-burner motor to be produced in recent years featuring reversible rotation in $^1/_8$ and $^1/_6$ hp ratings. Rotation can be changed by switching connections in a terminal box on the pulley-end flange face.

The new motors have the same flange mounting as did previous GE models and are over 50 per cent lighter. According to company engineers, the $^1/_8$ hp model weighs 11 lb, 56 per cent less than its forerunner.

Other features claimed include increased lubrication life, black enamel satin finish, and insulation designed to resist moist basement atmosphere. A manual reset thermal protector button is located on top of the motor close to the instruction nameplate.

Rod Packings

Industrial rod packings of braided asbestos, using an impregnation of 35 per cent Teflon (tetrafluoroethylene resin), are now being marketed by United States Rubber Co., Rockefeller Center, New York 20, N. Y.

The new type of packing, according to the company, is expected to provide longer service than rod packings previously available because of its higher resistance to acids and alkalies. The principal advantage of the resin for industrial packings is its high resistance to chemicals, including virtually all petroleum and coal tar solvents. It will perform satisfactorily in all temperatures ranging from 90 F to 500 F, the firm declares.

Two types of asbestos with tetrafluoroethylene will be supplied by U. S. Rubber. The white asbestos impregnated with the resin is designed for dilute acids, caustics, and various chemicals on centrifugal or reciprocating pumps and valve stems. The blue asbestos is recommended for use on similar installations where acids and chemicals of higher concentration are handled.

Fork Lift Truck

A Mobilift 4,000-lb-capacity fork lift truck is now in production at Mobilift Corp. plants in Portland, Ore., according to a company announcement. Called the D-424, the truck is powered by a Chrysler six-cylinder, 65-bhp industrial engine, with a power transmission system said to be an exclusive engineering feature of this new model.

A Chrysler Gyrol fluid coupling is used in conjunction with Mobilift's multiple disk, oil-immersed clutch, and constant mesh transmission. Four-pinion differential with full-floating axles is used to complete the assembly. A push-pull lever controls the two-speed transmission which gives a high range of 11 mph and $5^3/_4$ mph in low-range forward and reverse.

The D-424 has been designed for easy operation and driver comfort. The floor board is $23^1/_2$ in. above the floor. The operator has free access to his seat from the left or right side of the truck. Steering mechanism is a combination ball-bearing worm-and-nut type. The one-piece hood is hinged on the counterweight.

The wheelbase of the D-424 is 48 in. with an overall length of $82^1/_2$ in., less forks, giving

When attending the **ASME** *meetings in New York*

COME TO PHILADELPHIA

to see the

24TH EXPOSITION OF CHEMICAL INDUSTRIES

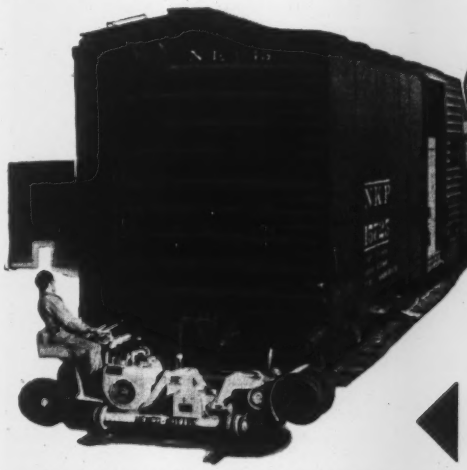
ESTABLISHED 1915

NOV. 30 to DEC. 5

COMMERCIAL MUSEUM & CONVENTION HALL

Meet and talk with the men who are translating research into the latest developments in the chemical industry. Almost 500 exhibits all on one floor. Here's an opportunity to exchange ideas with leading technical men serving the chemical processing industries. Get up-to-the-minute data on the latest procedures that apply to your plant operations. Save time (and hurried hunting for) in learning the newest and best advanced techniques.

Application forms for hotel accommodations are available by writing to INTERNATIONAL EXPOSITION COMPANY, 480 LEXINGTON AVE., NEW YORK 17, N. Y.



WISCONSIN-POWERED

HEMCO-MOTIVE

Switching Unit

Moves 3 Cars at a Time!

Here's a practical "locomotive" for switching and spotting cars on your sidings — at a great saving in man-hours, plus increased safety and ever-ready convenience . . . at an operating cost of about 1 ½ gals. of gasoline per hour!

A 25 hp. Model VF4 Wisconsin Heavy-Duty Air-Cooled Engine furnishes dependable power for all phases of HEMCO-MOTIVE operation . . . off-track mobility, climbing up and over the rails, operating the hydraulic lift that "couples" the unit to the car, and handling all switching and spotting maneuvers . . . delivering a 7400-lb. drawbar pull through 4-wheel drive, moving up to 3 loaded freight cars at a time, at a rail speed of 150 ft. per minute! Hemco Manufacturing Inc., Argonia, Kansas, is the builder.

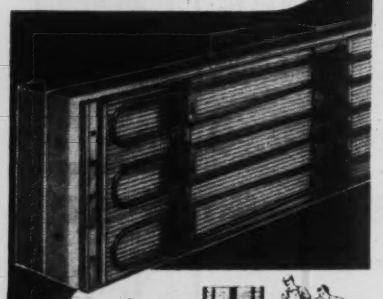
It's another typical Wisconsin Air-Cooled Engine original equipment application . . . again illustrating how these fine engines fit both the JOB and the MACHINE.

WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 46, WISCONSIN

For BAKING, CURING, DEHYDRATING, etc.
on an efficient, production line level



An oven in days—not months

CHROMALOX
Electric
RADIANT PANELS

Ready to install, 1-ft. x 4-ft. and 2-ft. x 4-ft. pre-engineered Chromalox Panels generate intense, far-infrared energy to meet many processing and finishing heat needs. Tunnels in sizes to fit the work, can be quickly assembled in minimum space. Color-blind far-infrared radiation is absorbed efficiently by all colors and textures, can be controlled precisely, and gives other advantages possible with no other heat source!

Send For Bulletin CS-605

It gives details on pre-engineered Chromalox Electric Radiant Panels and shows how they meet your heat requirements.

Radiant Heating Division 18-39-A
EDWIN L. WIEGAND COMPANY
7646 Thomas Blvd., Pittsburgh 8, Pa.
I am interested in Chromalox Radiant Heat for_____

☐ Send me Bulletin CS-605 on Radiant Heaters.
☐ Have your Chromalox representative contact me.
☐ Send me Catalog 50 which shows other Chromalox Units.

Name_____ Title_____
Company_____
Street_____
City_____ Zone____ State_____

CHROMALOX
THE BEST IN ELECTRIC HEAT

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

the new Mobilift an 80-in. turning radius for intersecting aisles of 69½ in. The overall width is 39 in. Hoisting on the new D-424 is by a displacement-type hydraulic cylinder. Ball-bearing rollers guide the telescoping channels. The standard mast height is 83 in. with a lifting height of 108 in. Optional masts and lifting heights are available.

The D-424 is available through Mobilift branch offices in Chicago, Ill.; East Rutherford, N. J.; Atlanta, Ga.; Dallas, Tex.; Berkeley, Cal.; the main office at 409 S. W. 13th Ave., Portland 5, Ore.; and the dealer organization throughout the country.

Miniature Oscillograph

A wide-band, quantitative oscillograph which features quality, laboratory performance, and versatility, with "brief-case" portability, has been announced by the Instrument Div. of Allen B. Du Mont Laboratories, Inc. The new instrument, designated the Du Mont Type 301-A, measures 9⅛ in. high × 6½ in. wide × 16⅝ in. deep, and weighs 20 lb. This size and weight include a protective front panel-cover and three accessory probes and cables.

Bandwidth of the new Du Mont Type 301-A extends from 10 cps to 4 mc (20 per cent down). Circuits for calibration of both time and amplitude are incorporated. The tight-tolerance Du Mont Type 3WP-1 Cathode-ray Tube is employed in the Type 301-A.

Said to be particularly well suited for field use, the Du Mont Type 301-A claims rugged construction, and capability of withstanding conditions of temperature and humidity far beyond the range of ordinary equipment. The Type 301-A is recommended for field maintenance of microwave relay links, computers, airborne instruments, and other equipment in the field or laboratory. Primary power requirement for the Type 301-A is 115 v, 50 to 1000 cps. Complete electrical and mechanical specifications are available from the Technical Sales Dept. at 760 Bloomfield Ave., Clifton, N. J.

Mold Drying

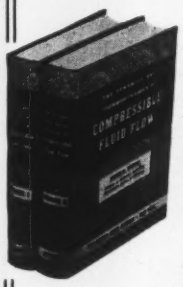
Ohio Steel Foundry, at Springfield, Ohio, has replaced overnight air-drying and now dries silicone wash on molds for gear castings in 7½ min with Chromalox far-infrared electric radiant heaters, the Edward L. Wiegand Co., has reported. A single bank of 24 heaters, rated at 1.8 kw each, is suspended over the conveyor carrying the molds. During drying, the heaters are lowered to within a few inches of the top of the molds, but when not in use they can be raised to the ceiling.

Only the drag half of each mold is sprayed with the silicone wash in this operation. The cope is not sprayed because it contains very little cavity and none of the gear tooth surface. About 25 drag molds are dried per hour. After drying, the molds are cooled by a fan at the end of the heating line. This prevents condensation from forming and permits immediate mounting of the cope and pouring of the mold. Conveyorized production is now accomplished without interruption, and smoother gears are produced with less casting-cleaning labor, according to the company.

More information about mold drying and application of Chromalox radiant heaters for other industrial uses can be obtained from Edwin L. Wiegand Co., 7646 Thomas Blvd., Pittsburgh 8, Pa.

ANNOUNCING . . .

The Dynamics and Thermodynamics of Compressible Fluid Flow



Ascher H. Shapiro
Massachusetts Institute of Technology

NEW, two-volume reference provides a wealth of material—for mechanical engineers, aeronautical and chemical engineers, physicists, and applied mechanicians — directly applicable to today's engineering problems. Covering virtually every phase of compressible fluid mechanics, its scope ranges from fundamentals to analytical development of design methods and advanced exemplary methods. Discussions, based on clear physical reasoning, theoretical treatment, and empirical results, make this a work of high practical value. All important results are reduced to chart form; appendix contains numerical tables on compressible-flow functions to facilitate computations. *Vol. I (available now) 603 ills., 660 pages. Vol. II (ready Spring, 1954) 580 ills., 600 pages. $30 per set. $16 per volume.*

GAS TURBINES

HARRY A. SORENSEN
State College of Washington

PROVIDES a valuable working knowledge of the gas turbine as a power plant which can—through modifications in design and construction—be applied to many classes of service. Covers thermodynamic principles, elements of design, and general construction features of the gas turbine power plant. Includes recent advances made in aircraft gas-turbine engines and jet propulsion; stresses axial-flow compressors and turbines. Duplication is avoided through organization by topic and function, rather than by type of power plant. Operating data included. *432 ills., 460 pages.* **$6.50**

SIMILITUDE IN ENGINEERING

GLENN MURPHY
Iowa State College

ORGANIZES and thoroughly analyzes the problems of model design and the interpretation of model tests. First book to show how scale models may be used to work out problems not easily solved by analytical means. Complete coverage of dimensional analysis used in the development of scale models; design of distorted models and their application to the problems of engineering; and the analogous relationship of the scale model to the actual structure. *56 ills., 302 pages.* **$7**

At your bookstore or direct from . . . . . .

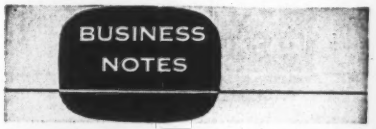
THE RONALD PRESS COMPANY
15 East 26th St., New York 10

Roller-Type Pump

A recent addition to the line of equipment sold by the Eclipse Fuel Engineering Co., Rockford, Ill., is a new direct-drive, roller-type pump for handling liquids with lubricating characteristics. This pump is claimed to be able to operate at higher speeds, with the same liquids, than more tightly fitted mechanisms. Liquids containing foreign matter that would jam other pumps can also be handled efficiently, without damage.

These advantages, according to Eclipse are provided without sacrificing good suction and pressure characteristics. The company also states that continuous circulation of liquid reduces the effects of cavitation and permits satisfactory operation at higher speeds than are desirable with other positive displacement designs.

The pump is intended primarily for use with the new Eclipse CF closed-flame gas-oil burners, according to the company. More information on the Series 50 can be obtained from the Eclipse Fuel Engineering Co., Rockford, Ill.



Morse Chain Names Additional Detroit Distributor

Further expansion of Morse Chain Co.'s industrial distributor organization has been announced with the appointment of Abrasive & Supply Co., 15443 Woodrow Wilson Ave., Detroit 3, Mich., as an additional distributor for the Detroit industrial area. This is the 21st Morse distributor to be added since the first of the year.

Morse Chain Co. has manufacturing plants in Detroit, Mich., and Ithaca, N. Y.

Builders-Omega Move Mid-West Office to Chicago

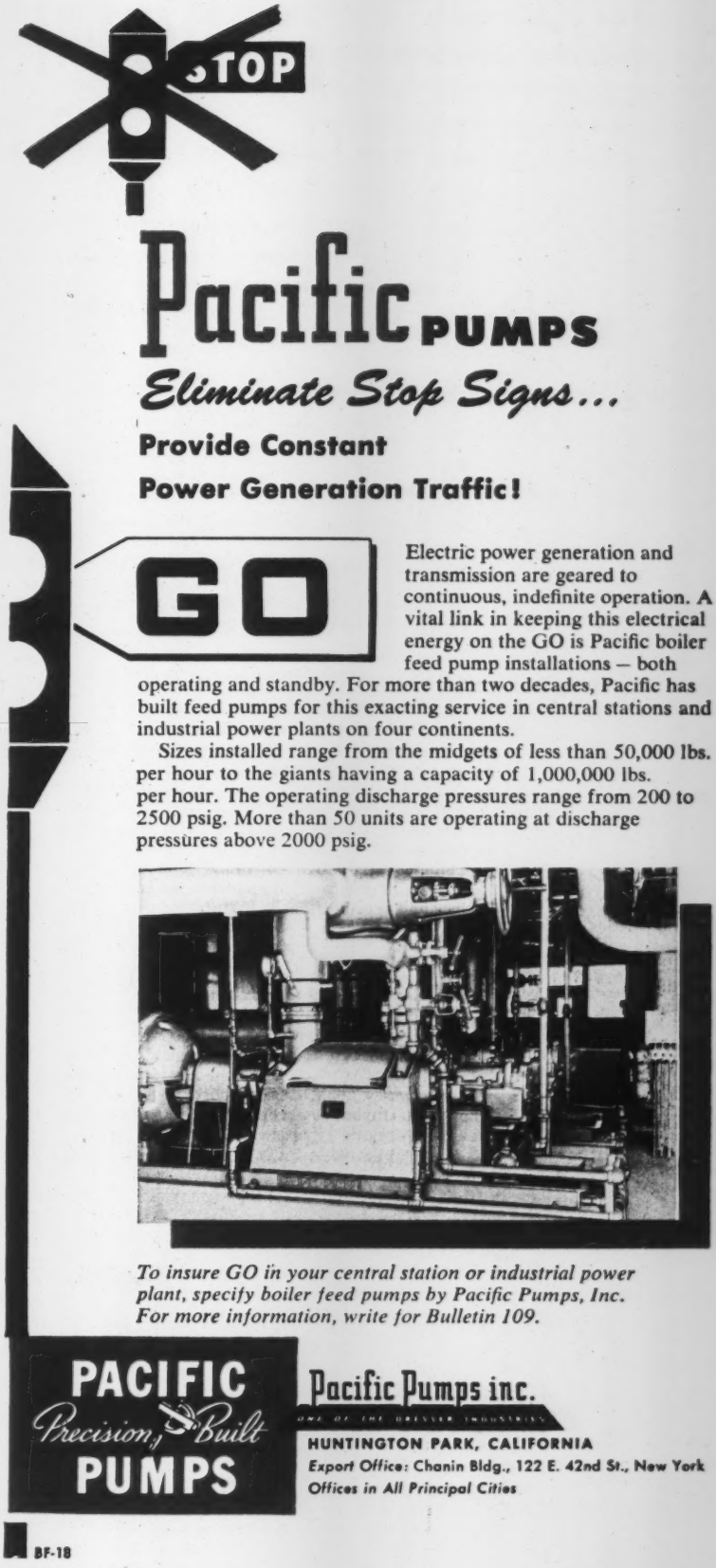
Announcement of the moving of their mid-western sales office and service center, formerly located in Wilmette, Ill., has been made by Builders-Providence, Inc., and the Omega Machine Co. On July 15, 1953, their address became: B-I-F Industries, 2039 West Howard St., Chicago, Ill.

There will be no change in personnel resulting from the move. Addresses of local representatives in Moline, Ill.; Kansas City, Mo.; St. Louis, Mo.; Minneapolis, Minn.; and Omaha, Neb., will not be affected by this move.

New Departure Appoints Advertising Manager

Harry W. Holdsworth became advertising manager for the New Departure Division of General Motors Corporation on August 1, succeeding Carleton B. Beckwith, who retired on July 31 after 23 years in the position and 42 years with the division, it was announced by Charles D. McCall, general sales manager.

Mr. Holdsworth has been with New Departure since 1920. He entered the firm's employ as a draftsman-designer in its mechanical department. Two years later he was assigned to writing technical literature on application of ball bearings. In 1933 he was named assistant advertising manager, duties he fulfilled until becoming advertising manager.


STOP
Pacific PUMPS
Eliminate Stop Signs...
Provide Constant
Power Generation Traffic!
GO
Electric power generation and transmission are geared to continuous, indefinite operation. A vital link in keeping this electrical energy on the GO is Pacific boiler feed pump installations – both operating and standby. For more than two decades, Pacific has built feed pumps for this exacting service in central stations and industrial power plants on four continents.
Sizes installed range from the midgets of less than 50,000 lbs. per hour to the giants having a capacity of 1,000,000 lbs. per hour. The operating discharge pressures range from 200 to 2500 psig. More than 50 units are operating at discharge pressures above 2000 psig.
To insure GO in your central station or industrial power plant, specify boiler feed pumps by Pacific Pumps, Inc. For more information, write for Bulletin 109.
PACIFIC
Precision Built
PUMPS
Pacific Pumps inc.
ONE OF THE DRESSER INDUSTRIES
HUNTINGTON PARK, CALIFORNIA
Export Office: Chanin Bldg., 122 E. 42nd St., New York
Offices in All Principal Cities
BF-18

ELECTRO-MECHANICAL

Engineers

For research and development of electro-mechanical radar and computing equipment.

Significant advancements in the fields of airborne radar and fire control systems are requiring further applications of electro-mechanical techniques in the Hughes Radar Laboratory.

The company

Hughes Research and Development Laboratories, located in Southern California, form one of the nation's leading electronics organizations. The Laboratories are presently engaged in the development of advanced electronic systems and devices which are produced by the Hughes manufacturing divisions.

Areas of work

The work calls for devising reliable, maintainable, manufacturable designs for precision equipment developed in the Hughes Radar Laboratory. The equipment consists of mechanical, electronic and microwave devices and systems to be manufactured in quantity. The equipment designs require the use of such advanced techniques as subminiaturization, unitized "plug-in" construction, with emphasis on design for volume production. Knowledge of electronic components, materials, finishes and specifications is useful.

The future

Engineers experienced in the field of electro-mechanical design for production or those interested in entering this field will find outlets for their abilities and imagination in these activity areas. New electro-mechanical techniques are opening new applications for airborne electronic equipment. Hughes engineers will have the full benefit of working experience in these fundamental developments.

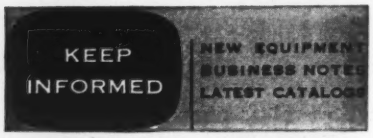
Assurance is required that the relocation of the applicant will not cause the disruption of an urgent military project.

Address resume to **Scientific and Engineering Staff**

Hughes

Research and Development Laboratories

Culver City, Los Angeles County, California



J & L Changes Alloy Name

Jones & Laughlin Steel Corp. has announced that its high-tensile low-alloy steels, known as "Otiscoloy," henceforth will go by the trade name of "Jalten."

The name-change conforms to the pattern of other Jones & Laughlin trade names. These include "Jalloy," an alloy steel resistant to abrasion, and "Jalcase," a case-hardening, cold-finished steel.

Cleaver-Brooks Names Western Distributor

The Cleaver-Brooks Co., Milwaukee, Wis., has announced the appointment of the D. E. McCulley Co., Omaha, Neb., as exclusive manufacturers' representative for the sale of Cleaver-Brooks Self-Contained Boiler Equipment.

Located at 1903 Jones St., Omaha 2, Neb., the D. E. McCulley Co. will handle a territory consisting of western Iowa and central and eastern Nebraska.

High-Slip Induction Motor

A four-page bulletin describing the company's totally enclosed, fan-cooled, high-slip induction motor for punch press service has been announced as available from General Electric Co., Schenectady 5, N. Y.

Designated GEA-5968, the four-color publication discusses the design of the Type KRX motor and explains how an extended bar rotor helps reduce the problem of rotor heat. Cutaway drawings illustrate the ventilation and construction features of the motor which is specifically designed for heavy-duty high-inertia applications on drawing and forging presses in the automotive and metal working industries. Also included are rating and frame sizes, a speed-torque curve, and detailed dimension information.

Industrial Thermometers

Precision Thermometer & Instrument Co., Philadelphia, Pa., has announced publication of Bulletin E-2, a catalog presenting industrial thermometers. Both mercury-in-glass and bimetallic thermometers are featured. The first portion of the 16-page catalog presents technical data, details of construction, temperature scale ranges, and various forms of mercury-in-glass industrial thermometers in conventional 7-in., 9-in., and 12-in. case sizes.

Included also is a listing of thermometers for installation in ducts, piping, pressure vessels, etc., while the centerspread features thermometers of the separable-socket type and includes dimensioned sketches of all standard sockets. Offered in addition is a general-purpose thermometer of the separable-socket type, patterned after a military specification.

Also discussed is the use of the mercury-in-glass thermometer as a thermal protective device.

Bulletin E-2 will be sent on letterhead application to Princo, 1434 Brandywine St., Philadelphia 30, Pa., Attention: W. D. Laverell, Sales Mgr., Dept. E-2.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Portable Potentiometer

Bulletin 1210 covers the Brown Portable Potentiometers, with direct-reading temperature, millivolt, and extended-range scales. Wiring diagrams, instructions, specifications, and special features are also included. Copies are available from Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne & Windrim Ave., Philadelphia 44, Pa.

Fluid Drive

American Blower has announced the release of a two-color, 24-page bulletin covering the Type VS, Class 4 Gyrol Fluid Drive. It covers such subjects as applications, advantages, features, selection, and dimensions.

The bulletin is intended to be of value to engineers interested in obtaining adjustable speed operation in a range from 100 to 2500 hp. Copies of the bulletin, No. 9319, are available upon request by writing to American Blower Corp., Detroit 32, Mich.

Welding Nickel Alloy Steel

"The Welding of Nickel Alloy Steels," Bulletin A-93, 44 pages, with tables, graphs and illustrations, is a study of the various welding techniques, including some of the newer inert gas processes, electrodes, preheat treatments, and post-heat treatments. Typical results that can be expected are given for the low-alloy high-strength steels, low-carbon and medium-carbon engineering alloy steels, and special steels. Copies are obtainable from International Nickel Co., Inc., New York 5, N. Y.

Resonant-Reed Hand Tachometer

"The Story of Speed Measuring by Resonance" is the title of a publication dealing with the measurement of speed by resonance or vibration. The booklet, Bulletin 31-P8, declares that a series of tuned steel reeds can indicate speeds more accurately than most mechanical tachometers and speed indicators.

The Frahm Tachometer, manufactured by James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa., measures speed without requiring any contact with moving parts. Copies of the bulletin are available on request.

Lock Nuts

The Security Locknut Corp. is offering a catalog of its line of lock nuts. The Security Locknut is a combination of a standard nut and a retainer. Nominal sizes available are: American Standard Heavy and Thin, $^{7}/_{16}$ to 3 in.; American Standard Light Thick and Thin, $^{7}/_{16}$ to 2 in.; Finished Hexagon and Thin, $^{7}/_{16}$ to 2 in.; and "Rail-Loc" square locknuts (AREA specifications), $^{3}/_{4}$ to $1^{3}/_{8}$ in.

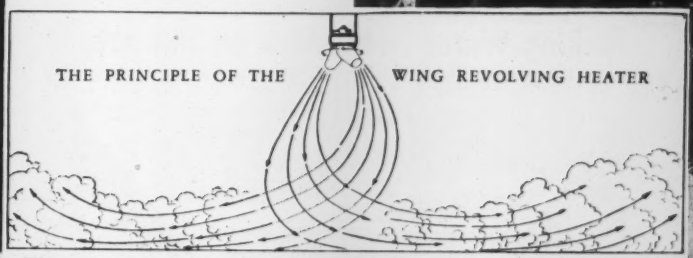
Copies of the catalog are available on request from Security Locknut Corp., 1500 North Ave., Melrose Park, Ill.

Drilling Unit

A new power-source for operating drills and cutting tools is claimed by "Drillunit," which is hydraulically operated. A recent catalog-folder gives photos of single and multiple installations, and states that the two Drillunit models are small compared with other units of similar capacity, while having an especially long stroke. The hydraulic feed is said to be unusually accurate and dependable. Folder and data sheets will be sent by Drillunit, Inc., 635 Mt. Elliott, Detroit 7, Mich.

HEAT THAT MOVES AROUND

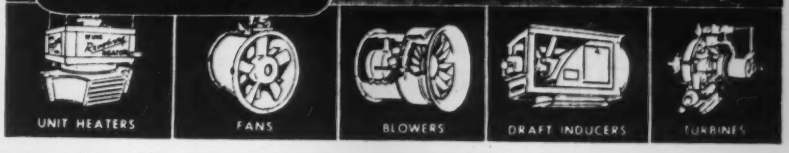
THE fact that the discharge outlets of WING Revolving Unit Heaters keep the heated air in constant, gentle motion is one of the reasons why nationally known firms like the Budd Company have installed them in their plants, both at Philadelphia and in the one shown in this photograph, at Gary, Indiana. The big blanking and forming presses in this great plant present a natural barrier to ordinary fixed discharge heating systems, but not to the moving streams of heated air from the WING Revolving Heaters, even suspended, as they must be, far above the floor, to clear the cranes. That is equally true in the summer time when, with steam turned off, the cooling breezes from the revolving discharge outlets keep workers comfortable on the hottest days. Investigate. Write for Bulletin HR-6.



The moving streams of heated air (or cooling breezes in summer) sweep slowly around through 360 degrees, covering successively every direction. The air velocity is sufficient to carry to walls, and remote corners and the constantly changing direction of flow causes the air to find its way around obstructions.

Wing

L. J. Wing Mfg. Co.
156 Vreeland Mills Road
Linden, New Jersey
Factories: Linden, N.J. and Montreal, Can.
In Europe: Etab. WANSON, Brussels, Belgium



What is the
CORRECT CHIMNEY
for your Plant?

Perforated Radial Brick
or
Reinforced Concrete

Our Engineering Services include recommendations, designs, specifications and plans based upon many years of specialized experience.

Our Maintenance Department inspects existing chimneys without inconvenience to you, makes reports and recommendations.

Our Repair Department heightens chimneys in operation, repairs damaged chimneys, installs aviation obstruction lights and lightning rod systems, points brick chimneys and puts your chimney in perfect operating condition.

Write today for Literature on Building and Repair Service.

Design—Construction
Linings—Water Proofing
Repairs
Aircraft Warnings
Lightning Rods
Demolition

200 ft. x 8 ft. Radial Brick Chimney designed and built for Illinois Institute of Technology, Chicago

CONSOLIDATED
CHIMNEY CO.
Engineers and Builders
6 South Dearborn St., Chicago 3, Ill.

KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Pipe Coupling

Folder No. 103 covering the Morris Economy Compression Pipe Coupling is available on request from the Morris Coupling & Clamp Co., Dept. L-13, Ellwood City, Pa. The manufacturer states that the coupling eliminates the necessity of threading, flaring, or grooving prior to the installation of pipe unions.

The couplings are available in sizes from $\frac{1}{2}$ in. to 4 in. A table of specifications and a price list are included in the folder.

Flexible Metal Hose

A 16-page illustrated two-color catalog featuring Chicago Metal Hose and Flexon Expansion Joints has been released by Flexonics Corp., formerly Chicago Metal Hose Corp. The catalog presents basic selection and installation data necessary to the proper application of flexible metal hose and pipeline expansion joints.

Section 1 gives expansion joint specifications for both the low- and high-pressure units, including background engineering facts essential to selection of the proper joints. Section 2 covers specification data for the basic Chicago Metal Hose corrugated and convoluted hose constructions, as well as information on fittings. Included in this section is complete coverage of CMH special-purpose assemblies, available as standard.

Requests for copies should be directed to Flexonics Corp., 1305 S. Third Ave., Maywood, Ill., asking for catalog CMH-128.

Stress Values for Ferrous Pipe and Tubing

A data card, designed to help individuals involved in the design and operation of tubular equipment at elevated temperatures and pressures, has been issued by the Tubular Products Div. of The Babcock & Wilcox Co.

Known as TDC 154, the data card tabulates the maximum allowable stress values (S values) of a complete range of seamless and welded carbon, alloy and stainless steel tubing and pipe. An adaptation of Table P-7 of the ASME Boiler and Pressure Vessel Code, the data card is complete with notes and formulas for the calculation of the maximum allowable working pressures of tubing and pipe. Copies of the data card are available free upon request to the sales offices of the division at Beaver Falls Pa.

Blind Rivets

Townsend Co., New Brighton, Pa., has issued a 12-page catalog describing in detail its line of Cherry Blind Rivets, the rivet that is installed by one man from one side of the work and is claimed comparable to conventional rivets in strength and installation speed.

The new catalog includes information on applications, mechanical specifications, types, descriptions, data on Cherry Blind Rivet Guns for application, and a list of stock blind rivets available. Townsend Co., New Brighton, Pa., or Townsend Co., Cherry Blind Rivet Div., Santa Ana, Cal., will forward Catalog TL-76 on request.

Spreader Stoker

A 16-page illustrated bulletin on the Detroit RotoStoker Type C-C has been issued by the manufacturer, Detroit Stoker Co. The Detroit RotoStoker Type C-C is a spreader stoker for boilers and steam generators with approximately 5000 to 75,000 lb per hr steam output capacity.

The Type C-C is continuous-cleaning with continuous ash discharge. Fuel supply, air supply, and ash discharge are synchronized with steam demand. Advantages of the Type C-C over intermittently cleaned spreader stokers are said by the manufacturer to be: higher burning rates; maintenance of continuous steaming capacities for indefinite periods; and smokeless operation over a wide range of capacities.

The bulletin is available from the Detroit Stoker Co., General Motors Bldg., Detroit 2, Mich.

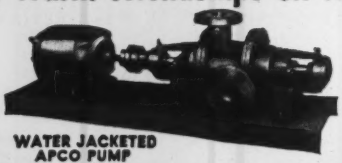
Clip Gate Valves

An illustrated four-page circular, describing its line of all-iron and iron-body, bronze-mounted "King-clip" Gate Valves, has been published by The Lunkenheimer Co., Cincinnati, Ohio.

King-clip valves are available in inside-screw, outside-screw, yoke, and quick-opening patterns, flanged and screwed ends. They also feature Stemalloy Stems, a patented silicon-bronze alloy, and Non-Slip Handwheels, each a Lunkenheimer development.

Circular No. 561, describing the King-clip line, is produced in two colors and contains specification data and leading dimensions. The publication may be obtained without cost by addressing The Lunkenheimer Co., Box 360, Cincinnati 14, Ohio.

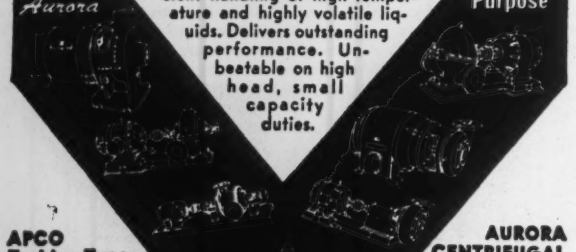
Making Warm Friendships on Hot Jobs



WATER JACKETED APCO PUMP
Developed especially for the efficient handling of high temperature and highly volatile liquids. Delivers outstanding performance. Unbeatable on high head, small capacity duties.

PUMPS "by Aurora"

For Every Purpose



APCO Turbine-Type PUMPS
—Ideal for "1001" duties where small capacities and high heads predominate. Get acquainted.

AURORA CENTRIFUGAL PUMPS
are available in many types and sizes—all noted for their streamline coordination between impellers and shells.

Write for CONDENSED CATALOG "M"

We Invite Your Special Pump Problems

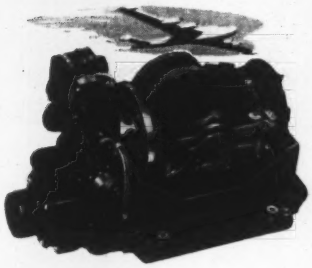
DISTRIBUTORS IN PRINCIPAL CITIES

AURORA Always PUMPS

AURORA PUMP COMPANY

SUBSIDIARY OF THE NEW YORK AIR BRAKE COMPANY

96 LOUCKS STREET, AURORA, ILLINOIS



Methods, process engineers . . .

Ever see a cageable gyro up close?

With the cover removed you can see it is a precision instrument . . . containing hundreds of accurately designed and fabricated parts.

You can work on such interesting automatic control projects — if you join Honeywell now.

We have several openings for experienced engineers.

Duties of the jobs. Supervise the tooling, processing and planning necessary to transform blueprints into finished products.

Requirements. B.S. or M.S. in Mechanical, Electrical, Industrial or Chemical Engineering desirable.

Atmosphere. A company which is growing rapidly, steadily and soundly. The challenge of production is ever present.

Openings. In Minneapolis and Philadelphia.

Write J. A. Johnson, Engineering Placement Director, Dept. ME-10-183, Honeywell, Minneapolis 8, Minnesota. Learn in detail about the significant opportunities at Honeywell. And be sure to ask for our new book, "Emphasis on Research."

MINNEAPOLIS **Honeywell**

First in Controls

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Resistance Welding

The how, what, and why of resistance welding is described in a new 16-page two-color bulletin which has been announced as available from the General Electric Co., Schenectady 5, N. Y.

Beginning with a description of the process, the publication, designated as GEA-5816, explains what metals are suitable for resistance welding, the essential steps in making a weld, and the principal types, including spot, seam, projection, and butt welds.

The basic components of electronic controls for regulating heat and timing are explained with accompanying photographs. Outline charts help visualize standard control combinations, and detailed description is given to six of the basic assemblies. Pictures and descriptions of accessories, along with a list of applications for this type of welding are also given.

6000-lb Crane Truck

An electric-powered, two-wheel drive crane truck is detailed in a two-color folder issued by the Elwell-Parker Electric Co., 4205 St. Clair Ave., Cleveland 3, Ohio. The truck, Type CX-4, has four-wheel steering, an overall length of 133 in., an overall width of 63 in., and an overall height of 76½ in. The crane has a capacity of 6000 lb at 7-ft radius.

The crane turns in intersecting aisles of 94 in.; it has a platform length of 34⅛ in. Travel speeds: without load, 4 mph; with 6000-lb load, 3½ mph.

The free literature devotes one page to engineering drawings which give detailed specifications. The facing page details such operating and construction features as speed, frame, crane unit, boom, drive axle, trail axle, load hoist unit, boom hoist unit, slew unit, and steering. In addition, application photos show the truck handling various loads.

Refrigeration Manual

A revised edition of the Trane Refrigeration Manual has been published by The Trane Co., La Crosse, Wis. The manual gives information on installation, operation, and servicing of refrigeration equipment for contractors and servicemen.

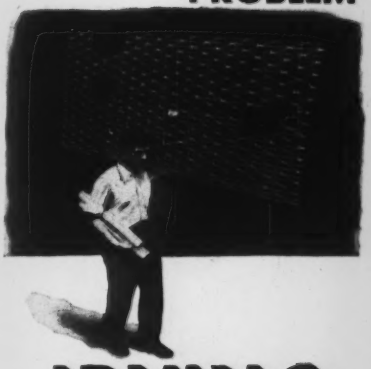
The latest edition of the Trane Refrigeration Manual contains two new chapters on refrigeration piping. Other changes include a new chapter on refrigeration system control, a revised chapter on service operation, and a completely revised refrigeration system service analysis chart.

The manual begins with a discussion of refrigerants and the refrigeration cycle. Succeeding chapters give information concerning the selection, installation, and servicing of all the component parts of refrigeration systems, including evaporators, compressors, condensers, thermostatic expansion valves, refrigeration system control equipment, motors and motor control equipment, heat exchangers, dryers, valves, piping, and accessories. The text is illustrated with photographs, drawings, charts, and graphs.

The manual was first published in 1946 and is now in its ninth printing. The revised, 125-page manual can be purchased from The Trane Co., La Crosse, Wis., for $1.50.

ENGINEER

WEIGHTY PROBLEM



IRVING ALUMINUM GRATING

Irving Aluminum Grating is the solution where **STRENGTH** and VERY LIGHT WEIGHT are wanted.

RUST PROOF

SPARK PROOF quality of aluminum grating makes it perfect for use in Petro-Chemical Industries

For Further Information on Irving Gratings, Write

IRVING SUBWAY GRATING CO., INC.

ESTABLISHED 1902

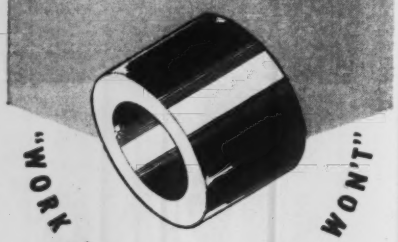
OFFICES and PLANTS at

5010 27th St., Long Island City 1, N. Y.

1819 10th St., Oakland 20, California

GRAPHALLOY
TRADE MARK REG. U. S. PAT. OFF.

OIL-FREE
SELF-LUBRICATING
BUSHINGS



"WORK WHERE OTHERS WON'T"

Widely Used Where Ordinary Oil Lubrication Is Impractical or Impossible.

EXCELLENT DURABILITY • CONSTANT CO-EFFICIENT OF FRICTION • APPLICABLE OVER A WIDE TEMPERATURE RANGE — EVEN WHERE OIL SOLIDIFIES OR CARBONIZES **• OPERATE DRY, OR AT HIGH SPEEDS SUBMERGED IN WATER, GASOLINE AND OTHER LIQUIDS • EXCELLENT FOR CURRENT-CARRYING BEARINGS**

GRAPHALLOY materials are also in wide use for oil-free, self-lubricating piston rings, seal rings, thrust washers, friction discs, pump vanes etc.

OTHER GRAPHALLOY PRODUCT

BRUSHES

CONTACTS

For applications requiring low electrical noise, low and constant contact drop, high current density and minimum wear. Used for SELSYNS, DYNAMOTORS, SYNCHROS, ROTATING STRAIN GAGE pick-ups and many other applications. Brush Holders and Coin Silver Slip Rings also available.

GRAPHITE METALLIZING CORPORATION
1058 NEPPERHAN AVENUE • YONKERS, NEW YORK

☐ Please send data on Graphalloy Oil-Free BUSHINGS.
☐ Send data on BRUSHES and CONTACTS.

NAME & TITLE
COMPANY
STREET
CITY ZONE STATE

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Circulation Heaters

Typical applications and operating characteristics of Chromalox electric circulation heaters are featured in a new 8-page bulletin by Edwin L. Wiegand Co. The folder explains that the automatic circulation heaters give efficient, automatically controlled heating of water, steam, oil, heat-transfer media, and air and other gases for industrial processes.

Chromalox Circulation Heaters are packaged units complete with built-in elements, heating chamber, thermostat, insulation, and mounting lugs. They arrive ready to attach to pipe lines leading to oil tanks, processing kettles, revolving rolls, water storage tanks, etc. Photos and drawings show methods of installation and advantages of the packaged units for a variety of installations. Bulletin 701 should be requested from Edwin L. Wiegand Co., 7646 Thomas Blvd., Pittsburgh 8, Pa., for further information.

Proportioning System

A six-page bulletin, offered by Richardson Scale Co., pictures and describes the company's recently developed proportioning and materials handling system for automatically making up formulated mixes of bulk products.

Called Select-O-Weigh, the system uses a single automatic scale to cumulatively weigh different products. The amount of each product fed to the scale is preset by an operator at a remote control panel. Materials handled include feeds, foods, chemicals, powders, fertilizers, oils, pelletized rubber, and rock products.

The bulletin explains the operation of the electronic control system, discusses rates, accuracies, and goes into the possibilities of remote recording. Also explained is the actual formulating operation, the selecting, feeding, weighing, and mixing. The bulletin includes a large schematic drawing of a typical Select-O-Weigh system, showing the arrangement of bins, feeders, bulk scale, and batch mixers. Photos show a Select-O-Weigh control panel and an automatic scale set up for use with the system, and five models of Richardson scales used for the proportioning operation are described.

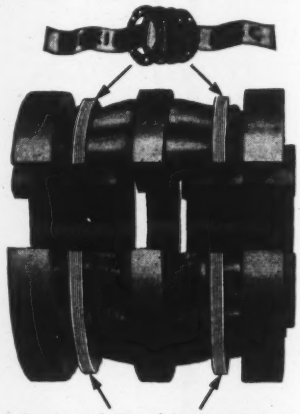
Copies of Bulletin #0351, are obtainable from Richardson Scale Co., Van Houten Ave., Clifton, N. J.

Give Gladly

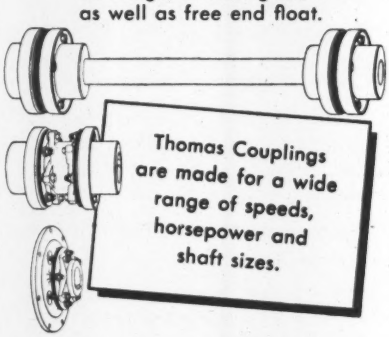
THE UNITED WAY

Specify THOMAS ALL METAL
FLEXIBLE COUPLINGS
for Power Transmission to avoid Costly Shut-Downs

DISTINCTIVE ADVANTAGES	
FACTS	EXPLANATION
NO MAINTENANCE	Requires No Attention. Visual Inspection While Operating.
NO LUBRICATION	No Wearing Parts. Freedom from Shut-downs.
NO BACKLASH	No Loose Parts. All Parts Solidly Bolted.
CAN NOT "CREATE" THRUST	Free End Float under Load and Misalignment. No Rubbing Action to cause Axial Movement.
PERMANENT TORSIONAL CHARACTERISTICS	Drives Like a Solid Coupling. Elastic Constant Does Not Change. Original Balance is Maintained.



Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.



Thomas Couplings are made for a wide range of speeds, horsepower and shaft sizes.

THE THOMAS PRINCIPLE GUARANTEES PERFECT BALANCE UNDER ALL CONDITIONS OF MISALIGNMENT

NO MAINTENANCE PROBLEMS

ALL PARTS ARE SOLIDLY BOLTED TOGETHER

Write for our new Engineering Catalog No. 51

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Silicone Rubber Products

An 8-page bulletin describing many of the silicone rubber products made by The Garlock Packing Co. has just been issued. The silicone rubber products described in the bulletin include: diaphragms, gasketing, sheet packing, oil seals, rings, insulation tape, rod- and valve-stem packings, and molded shapes for many industrial uses.

The bulletin points out the heat-resistant and aging-resistant features of silicone rubber and gives examples of typical applications. Copies of the bulletin, Garlock Silicone Products Bulletin AD-147, are available on request from The Garlock Packing Co., Palmyra, N. Y.

Roller Chain Sprockets

A new 16-page, pocket-size catalog (B55-53), listing prices and specifications for Morse Taper-Lock stock roller chain sprockets is now available from Morse Chain Co., 7601 Central Ave., Detroit 10, Mich. The $3^1/_2 \times 6$-in. catalog is printed on oil- and moisture-resistant paper.

Tables in the catalog list: horsepower ratings, Taper-Lock Bushing and sprocket specifications and prices, and roller chain and part specifications and prices for chain with pitches of $^1/_2$, $^5/_8$, $^3/_4$, 1, and $1^1/_4$ in.

Installation and removal procedures for Taper-Lock sprockets are listed in the catalog as well as horsepower selection charts, drive selection procedures, and service factor tables. Prices for Morse Packaged Roller chains which can be had in individual boxes of 5-, 10-, 50-, and 100-ft lengths are also included.

Masonry Coatings

Masonry surface coatings based on Bakelite and Vinylite resins are described in a pamphlet published by Bakelite Co., a division of Union Carbide & Carbon Corp.

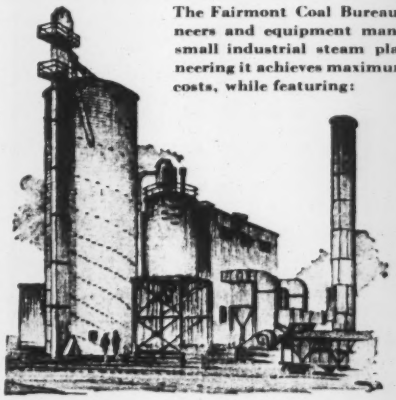
The 8-page brochure, "Bakelite and Vinylite Resin Coatings for Masonry," presents their outstanding advantages, varied applications, and results of actual service tests. Used on concrete, stucco, cinder block, brick, plaster, and porcelain surfaces, coatings based on vinyl resins, Bakelite phenolic resins, or Bakelite polystyrene latex are claimed to resist the effects of varying weather conditions and most acids, alkalies, and other chemicals, food stuffs, oils, and greases.

Applications ranging from homes and institutions to swimming pools and gasoline storage tanks are described in the pamphlet. These coatings may be applied by various methods, including spraying, brushing, or roller-coating. Pigmented resin-base finishes are available in a range of colors, and they may be flat, lustrous, or glossy.

Copies of brochure VC may be obtained by writing to Bakelite Co., 300 Madison Ave., New York 17, N. Y.

ONE BANNER
under which all may serve

Modern Design for the MODERN COAL



The Fairmont Coal Bureau has made available to consulting engineers and equipment manufacturers a TYPICAL DESIGN for the small industrial steam plant. Prepared as a guide to good engineering it achieves maximum economy of investment and engineering costs, while featuring:

- Fuel flexibility
- High efficiency
- Low fuel costs
- Minimum labor requirements
- Cleanliness, Automaticity, Reliability

Fairmont Pittsburgh Seam Coal is the MODERN COAL. Enormous reserves and inherently favorable mining conditions guarantee ample supply and low production cost. Modern mining and preparation facilities assure uniform quality.

Fairmont Coal Bureau engineers are freely available to help you solve fuel and combustion problems. Write for Technical Reference Bulletins and other valuable publications.

FAIRMONT COAL BUREAU

Dept. OME, 122 East 42nd St., New York 17, N. Y.

GEARS GALORE

In over 45 years of custom-gear making, we've produced gears for thousands of different uses and products. We've made gears for diesel engines and driers and drilling equipment; for machine tools and marine drives and medical equipment—gears of all types and sizes, for all kinds of jobs. We've learned from experience that no two gear requirements are entirely identical—that each gearing problem requires a separate solution. And from this variety of experience we've gained the ability and "know-how" to produce the *right* gear for any job you might have.

SPUR
WORM
INTERNAL
SPIRAL BEVEL
HELICAL
HERRINGBONE
*CONIFLEX BEVEL
SPLINE SHAFT

*Reg. U. S. Pat. Off.

THE CINCINNATI GEAR COMPANY
"Gears . . . Good Gears Only"
Wooster Pike and Mariemont Ave. • Cincinnati 27, Ohio

KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Silicones

"Tall Tales and Fabulous Facts," a 24-page booklet published by Dow Corning Corp., relates some tall tales about Paul Bunyan, Joe Magarac, Davy Crockett, and others, and compares their exploits with the "fabulous facts" of the uses of silicone products in industry.

The booklet was published on the tenth anniversary of Dow Corning, and is illustrated with cartoons and drawings. Copies are available on request from Dow Corning Corp., Midland, Mich.

Hydraulic System Maintenance and Oil Selection

A new bulletin covering recommendations for hydraulic-oil selection and basic hydraulic-system maintenance on machine tools and other industrial machinery is offered by Vickers Inc. Bulletin No. 1300-S, "Hydraulics for Industrial Machinery," reviews important characteristics of hydraulic oils, hydraulic-system operation under normal and extreme temperature and humidity conditions, and general maintenance procedures for Vickers' complete line of industrial hydraulic equipment. A table of common hydraulic-system difficulties and corrective action for each is included.

Requests for Bulletin Number 1300-S should be addressed to P. H. Emrich, Mgr., Product Service, 1500 Oakman Blvd., Detroit 32, Mich.

Bronze Gate Valves

The Lunkenheimer Co., Cincinnati, Ohio, has published two illustrated circulars describing its line of 150- and 200-lb S. P. Bronze Gate Valves. The circulars, complete with dimensions, describe the advantages of flange and screw gate valves equipped with either double or solid nickel-alloy wedge disks in rising-stem designs and with a single-wedge disk in non-rising-stem types. Valves in both pressure classes are available with "Stemalloy" stems and "Non-Slip" handwheels, developed by Lunkenheimer and featured exclusively on Lunkenheimer valves.

Copies of the circulars may be obtained without charge by writing to The Lunkenheimer Co., Box 360, Cincinnati 14, Ohio.

Speed Reducers

A new 15-page booklet, describing the complete line of Westinghouse speed reducers, is available from the Westinghouse Electric Corp.

Features of the equipment, manufacturing techniques, and applications are discussed in the booklet. Standard ratios available for all types of speed reducers are given. Special units developed for right-angle drives and in-line drives are discussed. Other speed reducers developed especially for a particular industry, such as steel, rubber, or mining, are described.

Copies of this booklet, B-5646, are available from Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.

Electrode Selector

A new four-page electrode-selector chart designed to present up-to-date information on the complete line of GE welding electrodes has been announced as available from the General Electric Co., Schenectady 5, N. Y.

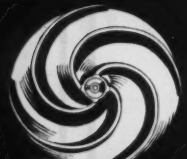
The chart, designated GEC-657E, contains condensed data on the company's line of mild-steel, low hydrogen-low alloy, low alloy-high tensile, hard-surfacing, and stainless-steel electrodes.

Tabular material includes welded properties, metal deposit analysis, technique, type of specification requirements met, major competitive types, description and advantages, and application data for each type of electrode listed.

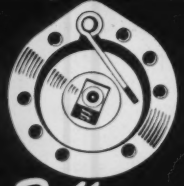
Flow Meters

"An Introduction to Flowrator Meters" is the title of Catalog 10-A-10, published by Fischer & Porter Co., Hatboro, Pa. The catalog discusses Flowrator meters and presents comparisons between these variable-area types and the variable-head meters. How the variable-area meter works, its basic flow equation, as well as information on calibration scales, metering range, permanent pressure loss, upstream piping effects, viscosity effects, purging, and pulsating flow, are all discussed. A description of F&P fabricating methods and facilities related to Flowrator meter production concludes the catalog.

Are you pumping $$ into wrong pump sizes



Pioneer
IMPELLER TYPE PUMPS
0 to 174 gpm 850 to 3450 rpm



Rollway
POSITIVE DISPLACEMENT
LUBRICANT PUMPS
1 pt. to 60 gpm 200 to 500 rpm

Over 400 models of standard PIONEER and ROLLWAY pumps to choose from. Thus you can be sure of exactly the right pump for your job . . . capacity-tested at the factory. No need to pay extra for capacities not needed.

To save on pump costs, power costs, maintenance costs, installation costs and space, ask for complete Manual and Catalog #43.

Headquarters
2750 Guardian Bldg.
Detroit 26, Michigan

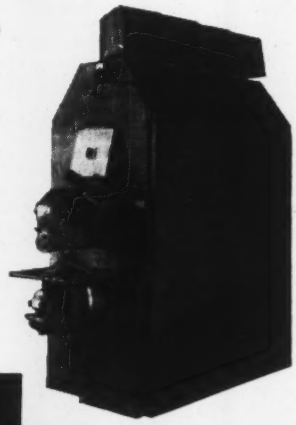
FACTORY
Paris, Kentucky

DETROIT HARVESTER Co.
PIONEER PUMP Division

RUGGED INDUSTRIAL HEATERS

CAPACITY FROM 300,000 to 7,500,000 B.T.U. per hour

- Maximum four pass heat transfer surface.
- Separate induced draft fan.
- Easy accessibility to accessories.
- Popular parts easily obtained anywhere.
- Heavy construction, free from vibration.
- Dust tight, Damp proof control panel box.
- Flexibility for special adaptions.
- Low initial cost.



Olson

DIRECT FIRED HEATERS
Gas, Oil, Coal or Dual Gas and Oil

ARTHUR A. OLSON & COMPANY
BROAD STREET, CANFIELD, OHIO

KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Pyrometer Supplies

Honeywell pyrometer supplies are illustrated and described in the newly revised Buyers Guide, 100-5. All general thermocouple assemblies and components are listed, as well as many special-purpose items. Prices and several pages on selection, care, and application of thermocouples round out the 48-page catalog. Requests should be directed to Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne & Windrim Ave., Philadelphia 44, Pa.

Lift-Truck Operator's Booklet

The fifth edition of "How To Operate A Lift Truck" has been published by Hyster Co. and is available free to lift-truck operators, supervisors, safety engineers, and other interested industrial and governmental personnel.

Two-color cartoon technique is used in the booklet, which contains information about the operation of a lift truck, preventive maintenance, safety, and basic materials handling. Drawings for setting up an obstacle course are also included.

Prepared for use as part of an operator training program, "How To Operate A Lift Truck" is slanted for both the beginner and the experienced operator. It can be studied individually by the operator himself or used as a guide by instructors. The booklet is available from Hyster Co., 2902 N. E. Clackamas St., Portland, Ore.

Drive and Conveyor Chains

Chain Belt Co., Milwaukee, Wis., is distributing a new bulletin on its drive and conveyor series Chabelco Chains. Designated is the "R," "RX," and "RR" series, the new chains combine several important advantages resulting in higher strength, longer life, and smoother performance, according to the company. Bulletin 53-59 contains "exploded" pictures showing details of chain construction, and includes a handy reference table, indicating the chains the new series replace.

Bulletin 53-59 can be obtained from Chain Belt Co., Dept P. R., Milwaukee 1, Wis.

Transformer Reference Book

A transformer reference book containing 33 authoritative articles for engineers has been issued by Allis-Chalmers Mfg. Co. The table of contents of the book lists such topics as "Combined Voltage and Base Angle Control Under Load," "Changing Taps Under Load," "How to Parallel Regulators to Increase Feeder Capacity," "Fundamentals of Audio Noise Measurements as Applied to Transformers," "It's Simple to Overload Transformers Safely if You Know How," and "Trends in Power Transformer Application."

The articles in this book, originally published in Allis-Chalmers Electrical Review, have been brought up to date with new pictures and new charts where necessary. Purchase price from Allis-Chalmers of the 170-page volume is $1.00.

Wire Springs

"Round Wire for Springs," Part II of the series on Metallurgy in the Mechanical Spring Industry, is in the August, 1953, issue of The Mainspring, publication of the Associated Spring Corp., Bristol, Conn.

The manufacture and properties of several springs of round wire are described. Copies are available on request from the Associated Spring Corp. or its divisions.

Remotely Operated Valves

Detailed information describing its remotely operated valves is now available from Fluid Controls, Inc. These valves are designed for use when it is not practical to place the relief valve in a normally accessible location or near other machine controls.

The Fluid Controls' remotely operated valve is a pilot-type relief valve with an internal pilot valve and provision for connecting one or more external pilot valves. The internal pilot valve is generally set at maximum rating of the pump or machine and the external pilot valve is adjusted to suit the operation being performed.

Catalog sheets contain detailed information on use, operation, and construction. Specific data on models available, pipe sizes, dimensions, weights, and rates are also included. Copies of this literature are available by writing to Fluid Controls, Inc., 1284 N. Center St., Mentor, Ohio.

SUPERVISION...

KEY to PRE-FABRICATED PIPING QUALITY

Every step in the fabrication of piping at Western Piping Supply is made under close and continuous supervision. From the day the customer's drawings enter the plant until the completed assemblies leave, this exact control is never compromised. "Watch-dogging" like this always assures WPS customers accurate, trouble-free installations in the field.

WESTERN PIPING SUPPLY DIVISION
THE LUMMUS COMPANY
504 WEST 145TH STREET, EAST CHICAGO, INDIANA
Representatives in Major Cities
FABRICATORS OF CARBON AND ALLOY PIPING

FOR EFFECTIVE SPRAYING AT LOWER COST

remember final control is the SPRAY NOZZLE you use!

In design... choose the Spray Nozzles that give you proper performance, with exact spray pattern, impact, spray angle and capacity. In application... be sure the nozzles as supplied are produced to close tolerances. Metallurgically, make certain the spray nozzles fit your use.

With Spraying Systems you can be sure of spray nozzles to meet all three requirements. *Let Spraying Systems Co. recommend Spray Nozzles to meet your needs best.*

YOUR GUIDE TO SPRAY NOZZLE SELECTION
Spraying Systems Co. Catalog No. 22... 32 pages, with complete performance data. Also write for Catalog 23... Pneumatic Atomizing Nozzles.

SPRAYING SYSTEMS CO.
3265 RANDOLPH STREET • BELLWOOD, ILLINOIS

FOR EFFICIENT SPRAYING MAKE SURE THE NOZZLE IS RIGHT

KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Process Equipment

Bulletin No. 550, "Specialized Equipment Designed and Built by Koven," describes and illustrates specialized equipment for processing, plant operation, handling, and storing which have been fabricated by L. O. Koven & Bro., Inc., 154 Ogden Ave., Jersey City 7, N. J.

The qualifications of Koven personnel and Koven facilities are given in the bulletin. Such equipment as mixers, pressure vessels, retorts, towers, tanks, stacks, and diesel engine parts are among those designed and built by the company. The bulletin can be obtained on request from the company.

Cemented Carbide Tools

Four more "Reports of Kennametal Performance" have been published by Kennametal, Inc., Latrobe, Pa., and are obtainable on request.

Report No. 435 describes the use of Kennamatic and Kendex insert tools in increasing production of cast-steel flange-mounted shafts. Report No. 436 concerns the saving made by a saw-blade manufacturer who substituted a solid Kennametal feed ratchet for a steel one.

Report No. 437 relates the advantages of the use of a Kennamill boring tool in rough-boring railroad car wheels. Report No. 438 discusses the savings obtained by using Kennametal boring tools in precision machining steel sleeves.

Drilling Tool Accessories

The Wohlnip Engineering Co. has released two bulletins on its products. The Wohlnip Non-Rotating Drill Stop, for controlling the depth of drilled holes, is illustrated in one bulletin. Available sizes are listed, with prices.

A Drill Extractor is the second accessory. Its operation is discussed step by step. The Extractor is available in a set of six sizes. Both bulletins are available on request from the Wohlnip Engineering Co., 390 Hillside Ave., Hillside, N. J.

Air and Hydraulic Control Valves

A condensed catalog of its "Quick-As-Wink" air and hydraulic control valves has been published by C. B. Hunt & Son, Inc., Salem, Ohio. The valves use a sliding sleeve construction.

Air valves for use at pressures up to 125 psi and temperatures up to 150 F; single plunger valves for air, water, or hydraulic oils for use up to 250 or 300 psi and 150 F; "O" and "OE" valves for air, water, or hydraulic oils, and air, respectively, for use up to 125 psi and 150 F; and hydraulic valves for use up to 5000 psi and 150 F are all covered in the catalog. Sizes, actions, and sectional views of body, plunger, packing, and interior operation are included. Requests for this catalog, Bulletin No. 531, should be addressed to C. B. Hunt & Son, Inc.

High-Speed Steel

The Latrobe Steel Co. has issued a technical bulletin on its Electrite UB-4 "Desegatized" High-Speed Steel. Characteristics of the steel, a high-carbon, high-vanadium, tungsten-base alloy, are discussed. Typical analysis is given, along with recommendations for forging, annealing, hardening, tempering, and grinding. Hardening data and tempering data are contained in tabular and graph forms. Typical uses are listed.

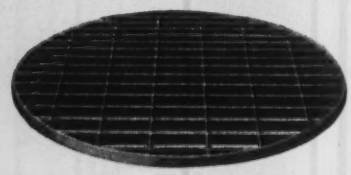
A list of the literature available on 34 grades of Latrobe steels concludes the bulletin, which is available on request from the Latrobe Steel Co., Latrobe, Pa.

Flame Failure Explosions

Fireye Bulletin CP21, "Guarding Your Properties Against Flame Failure Explosions," is a non-technical explanation of the explosion danger inherent in fuel-burning equipment, and the protection now available, published by Combustion Control Corp. According to the company, four out of five oil, gas, and pulverized-coal fired burners in industry do not have adequate protection.

The bulletin shows how to determine whether a fuel burner is adequately protected against explosion and briefly describes equipment now available which, it claims, provides complete protection. Copies may be obtained by writing to Combustion Control Corp., Dept. NB-8, 718 Beacon St., Boston 15, Mass.

REMOVE THE DANGER OF OPEN AREAS



Here's the Solution!

Blaw-Knox Electroforged Steel Grating is the ideal "coverage" for unprotected pits, light wells, basement stairways and other hazardous open areas. It is a one-piece steel "material" that provides safe footing under any conditions, and admits the maximum of light and air. *Strong . . . Silent . . . Secure.* Thousands of installations are still on the job after 20 years of traffic!

Send us dimensional sketch

We will then forward you price on grating cut to exact size. No nuts, no bolts, no special tools required. Don't delay . . . write today and make those danger spots both safe and usable!

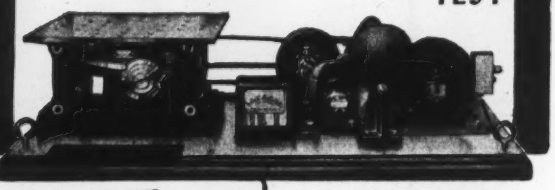
BLAW-KNOX COMPANY
Grating Department
BLAW-KNOX EQUIPMENT DIVISION
2105 Farmers Bank Bldg.
Pittsburgh 22, Pa.
Sterling 1-2700

ELECTROFORGED® STEEL

BLAW-KNOX GRATING

Give Parts, Assemblies a Positive

VIBRATION TEST



ALL AMERICAN VIBRATION FATIGUE TESTING MACHINE

Model 100 HL-A
Capacity 100 lbs. Produces vibrations horizontally. New 4-point linkage arm table support.

NATIONAL Bureau of Standards uses four, Mass. Inst. of Technology two, Western Electric 13, Westinghouse and G. E. 12 each. Basic equipment for YOUR testing laboratory or inspection department. In many plants a laboratory in itself. Detect excess weight—find structural weak spots.

For electronic, automatic, aircraft, crystal, optical and instrument makers, schools and research laboratories. Models to test parts from a few ounces to 100 lbs. Choice of horizontal or vertical table movement. Frequencies of 600 to 3600 v. p. m. Automatically or manually controlled. Send for Catalog F.

ALL AMERICAN Tool & Manufacturing Co.

8019 LAWNDALE AVE. • SKOKIE, ILL.

ALDRICH PUMPS

reduce fire risk and cut hydraulic fluid costs

• *With Aldrich Pumps* . . . oil *OR* water can be used as hydraulic medium. When water is used, you get insurance against plant damage or bodily injury due to oil fire.

Also with Aldrich Pumps . . . you get these important maintenance advantages:

REDUCED SPACE REQUIREMENTS

Due to higher operating speeds, you get whatever volume and pressure you need from a smaller, lighter, more compact pump.

SECTIONALIZED FLUID-ENDS

. . . afford maximum accessibility. Parts can be replaced easily and at low cost.

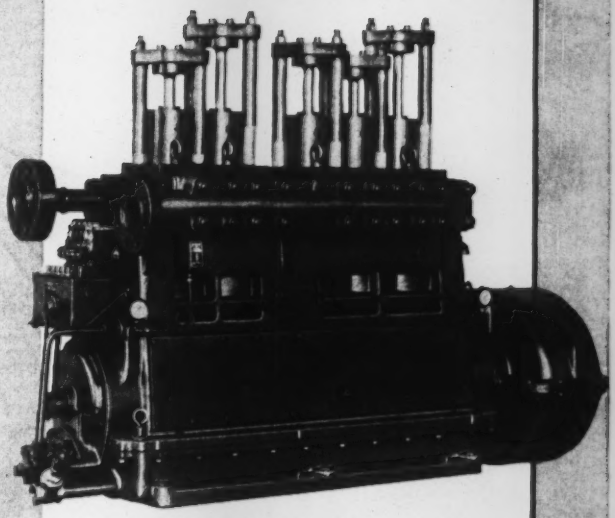
CHANGEABLE PLUNGER SIZES

In most cases plunger sizes can be changed merely by using new glands, throat bushings and packing in the same fluid-end: thus facilitating changes in pressure and volume requirements.

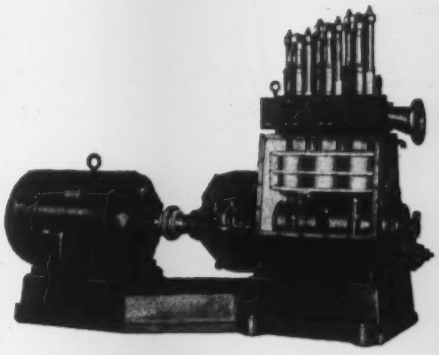
INTERCHANGEABLE WEARING PARTS

Among 3, 5, 7 and 9 plunger units all wearing parts are interchangeable. This is particularly advantageous where a combination of multiplex pumps is required, for it reduces spare parts, costs and inventories.

. . . Aldrich Direct Flow Pumps have given many years of satisfactory service to die casting manufacturers. Units are manufactured in 3″, 5″ and 6″ stroke sizes, in Triplex, Quintuplex or Septuplex models (50 to 900 hp).



Aldrich Direct Flow 5″ Stroke Quintuplex Pump. 150 hp.



Aldrich Direct Flow 5″ Stroke Triplex Pump. 100 hp.

Write us for catalogs, engineering service, or a representative's call. We invite your inquiries for pumps or complete central hydraulic systems.

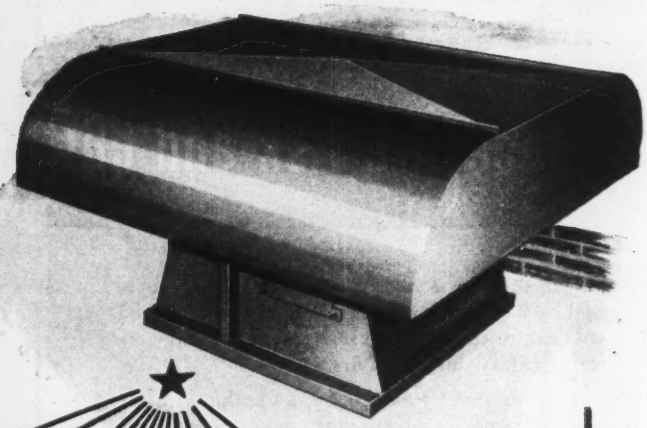
THE ALDRICH PUMP COMPANY

29 PINE STREET • ALLENTOWN, PENNSYLVANIA

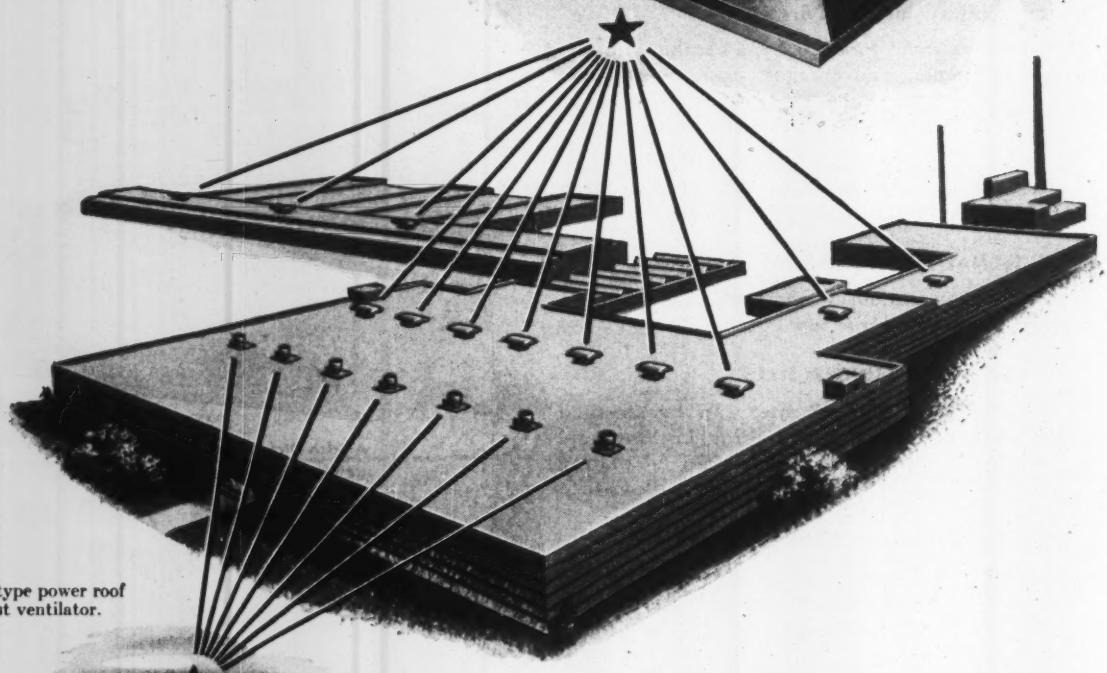
. . . Originators of the Direct Flow Pump

Representatives: Birmingham • Bolivar, N. Y. • Boston • Buffalo • Chicago • Cincinnati • Cleveland • Denver • Detroit
Duluth • Houston • Jacksonville • Los Angeles • New York • Omaha • Philadelphia • Pittsburgh • Portland, Ore.
Richmond, Va. • St. Louis • San Francisco • Seattle • Spokane, Wash. • Syracuse • Tulsa

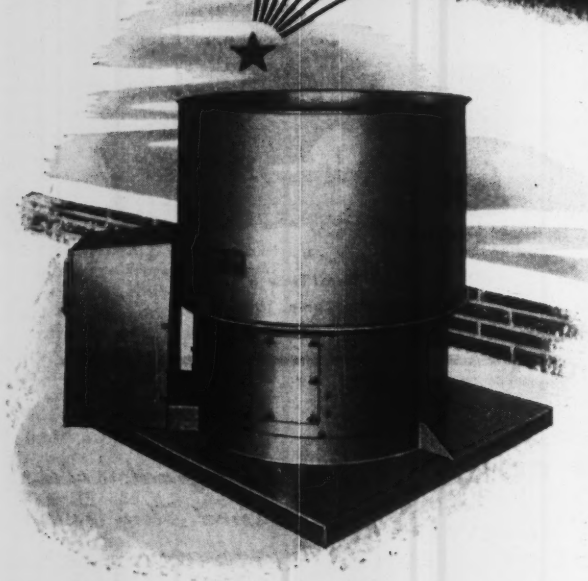
AMERICAN BLOWER
Power
Roof Ventilators



Hood type power roof exhaust or supply ventilator.



Upblast type power roof exhaust ventilator.



American Blower *power* roof ventilators give you the advantages of balanced ventilation, without the uncertainties of gravity units or the expense of a central system.

They're quickly and easily installed on all types of roofs. No extensive duct work is required; no valuable floor space is wasted. Use single units for spot ventilation; several units for large area coverage. American Blower power roof ventilators, supply or exhaust, are available in a wide range of capacities. They are designed to furnish balanced ventilation to industrial plants and commercial buildings.

Ask our nearest branch office for data.

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO

Division of American Radiator & Standard Sanitary Corporation

AMERICAN BLOWER

YOUR BEST BUY IN AIR HANDLING EQUIPMENT

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS

window shopping costs nothing... *can save you plenty*

It pays to "shop around" before you make your power transmission or conveyor chain selections. Because, in order to get the most for your money, you need the right chain for your designs. For example, a precision-finished roller chain is ideal for high speed drives. But, roller chain is not the economical, efficient choice for slow speed, heavy-duty service. A heavy-duty steel or cast chain may be your answer here. That's why it will pay you to "shop" through the *complete* Chain Belt line before you make your choice. There's a size and type to fit any power transmission or conveyor need.

Don't be handicapped by relying on a supplier with a limited line to answer all your needs. It may cost you more... may handicap the expected performance of your machines.

Your Chain Belt Field Sales engineer will be happy to assist you in making the exact chain selection that best fits your requirements. He is not prejudiced by the limitations inherent in an incomplete chain line... can recommend the chain that will give you the service you want... at the lowest possible cost. For complete information or engineering assistance, mail the coupon.

REX

BALDWIN-REX

Chain Belt COMPANY OF MILWAUKEE

Atlanta • Baltimore • Birmingham • Boston • Buffalo • Chicago
Cincinnati • Cleveland • Dallas • Denver • Detroit • El Paso • Houston
Indianapolis • Jacksonville • Kansas City • Los Angeles • Louisville
Midland, Texas • Milwaukee • Minneapolis • New York • Philadelphia
Pittsburgh • Portland, Ore. • Springfield, Mass. • St. Louis
Salt Lake City • San Francisco • Seattle • Tulsa • Worcester

Distributors located in principal cities in the United States and throughout the world
EXPORT OFFICES: 4800 W. Mitchell St., Milwaukee, and 19 Rector St., New York City.

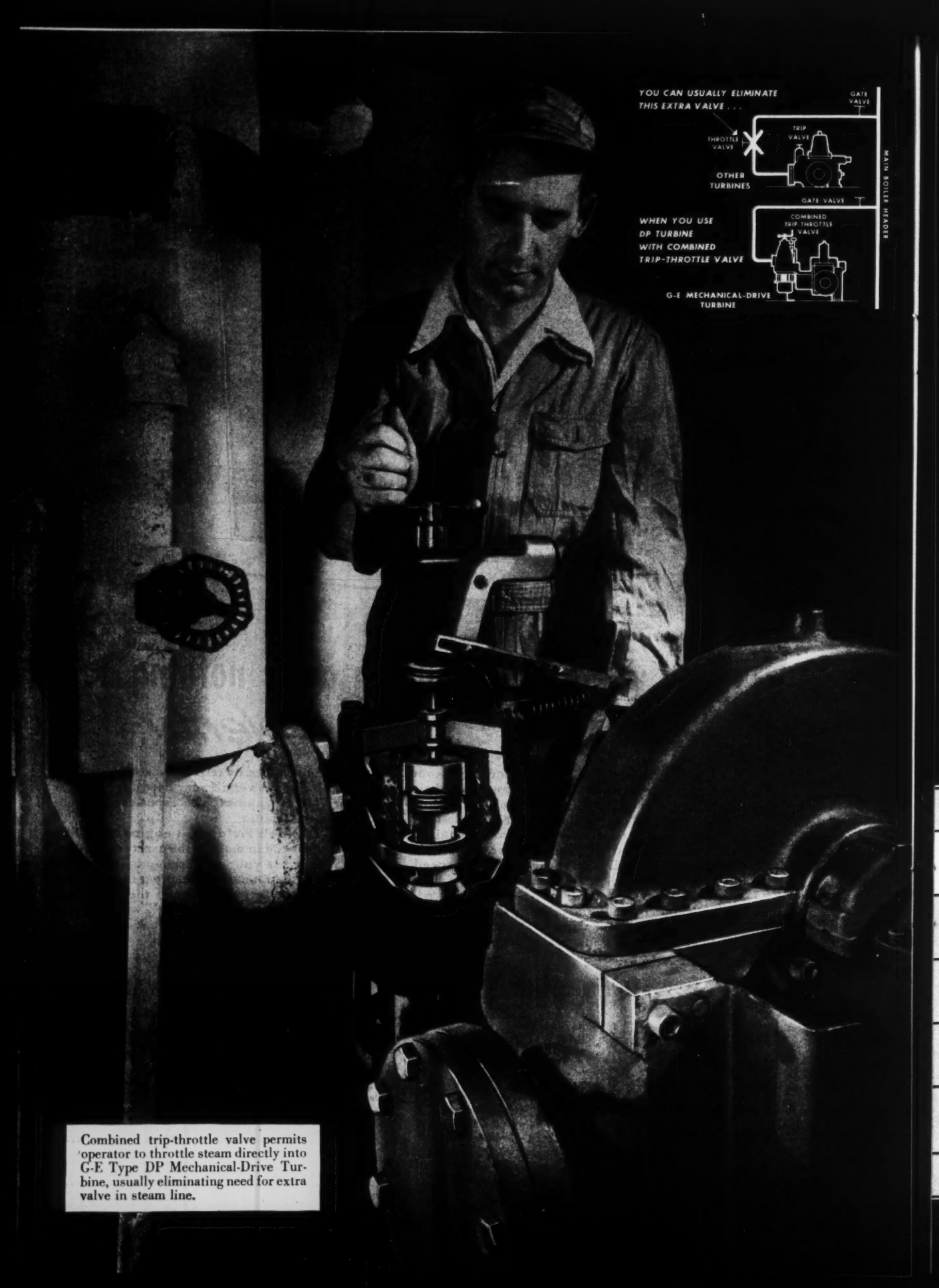
CHAIN BELT COMPANY 53-503
4765 W. Greenfield Ave., Milwaukee 1, Wis.
Gentlemen:
Please send me information on Rex and Baldwin-Rex chains
☐ For Power Transmission ☐ For Conveying ☐ For Tension Linkages
☐ Slide rule drive selector for slow to medium speeds

Name.....

Company.....*Dept.*.....

Address.....

City.....*State*.....



Combined trip-throttle valve permits operator to throttle steam directly into G-E Type DP Mechanical-Drive Turbine, usually eliminating need for extra valve in steam line.

ANOTHER PLUS VALUE OF G-E MECHANICAL-DRIVE TURBINES...

Combined Trip-throttle Valve Cuts Turbine Installation Costs

To save you the cost both of buying and installing a throttle valve in the steam line, General Electric designed into its standard Type DP mechanical-drive turbine a trip valve which also functions as a throttle valve. This feature alone can save you up to $200.00 at time of installation.

The combined trip-throttle valve controls steam admission to the turbine on starting and also shuts off all steam in case of overspeed. No need in most cases to shut off steam valves ahead of the turbine before restarting the unit. The combined trip-throttle valve can quickly be reset and the turbine put back on the line, saving you time in an emergency.

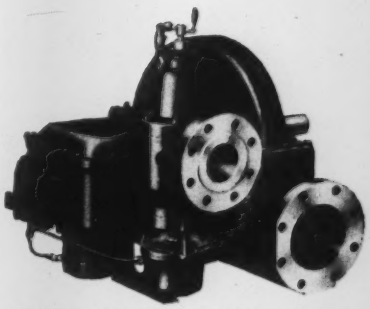
THIS COMBINED TRIP-THROTTLE VALVE is just one of many DP features which save you money. The chart below indicates other areas of savings.

Remember—the total cost is often more than just the sales price. But G.E.'s standard DP turbines include the extra features to save you extra costs. For more information contact your nearest G-E apparatus sales office. Write for bulletin GEA-4955A, "A New Standard in Mechanical-drive Turbines." General Electric Company, Schenectady 5, N. Y. 252-63

GENERAL ELECTRIC

INSTALLATION AND MAINTENANCE COST-SAVING FEATURES

THESE EXTRA FEATURES, STANDARD ON ALL G-E TYPE DP TURBINES, CAN . . .	Save You up to
COMBINED TRIP-THROTTLE VALVE Eliminate extra cost of buying and installing valve ahead of the turbine.	$200.00
SINGLE RESERVOIR FOR COOLING LUBE OIL Eliminate extra cost of piping cooling water to and between bearings.	50.00
MAJORITY OF PARTS INTERCHANGEABLE One set of spare parts protects several units—less money tied up in inventory.	100.00
METALLIC-LABYRINTH VALVE STEM BUSHING Eliminate labor costs of replacing soft packings; cut down-time production losses.	50.00
SHAFT MONEL-SPRAYED AT PACKING FIT Saves frequent cost of purchasing and installing carbon rings; contributes to long shaft and packing life.	20.00
ESTIMATED TOTAL SAVINGS	$420.00



G-E Type DP Mechanical-Drive Turbine

COMPARE THE FEATURES
EVALUATE ALL THE COSTS

See why G-E standard Type DP turbines are your most economical buy.

Are you only half an engineer?

All too often young engineers find themselves in jobs that only partially involve engineering — seldom get a chance to reap a full reward from their technical training.

But not here! We can offer you full-time engineering on some of the toughest problems facing any technical group — the development of advanced jet engines.

Here you'll have a real opportunity to sharpen your technical skills — an excellent opportunity to gain professional standing in your chosen field.

At Pratt & Whitney Aircraft you'll work with the leader whose engines power 75% of the planes operated by the commercial airlines of the world. And you'll have the stability of a corporation with commercial and military sales last year in excess of $600,000,000.

Interested in **real** engineering? Interested in building a career with a sound, well-managed company? Then send a resume to Mr. Paul Smith, Dept. ME 10.

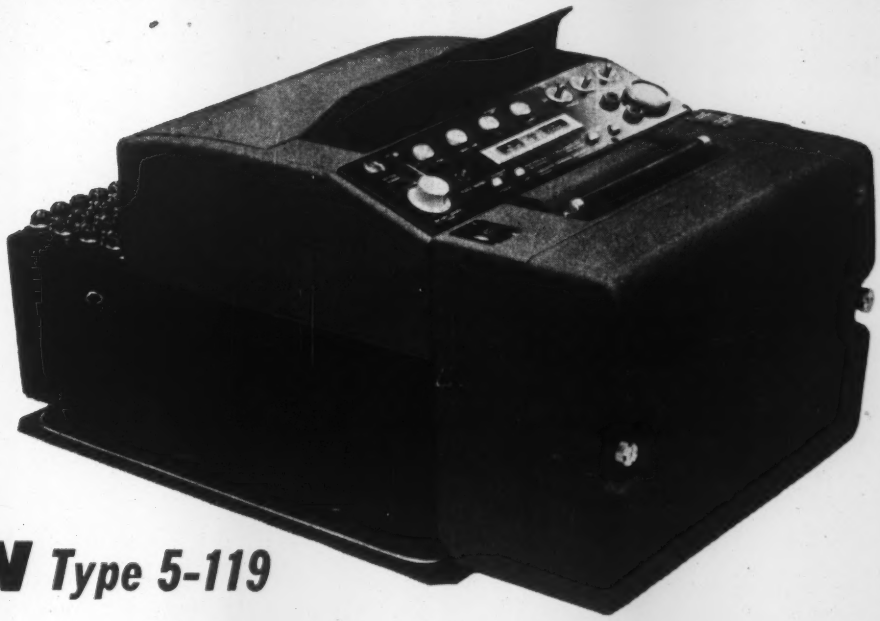
* * *

We particularly invite inquiries from:
Mechanical Engineers
Aeronautical Engineers
Engineering Physicists

* * *

PRATT AND WHITNEY AIRCRAFT
Division of United Aircraft Corporation
East Hartford 8 **Connecticut**

YOU *helped create this superior Recording Oscillograph*



NEW *Type 5-119*

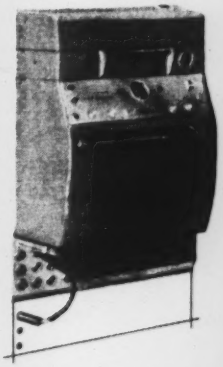
CONSOLIDATED'S new Type 5-119 Oscillograph was designed and built to customer specifications. Many major users were interviewed by our design engineers to determine the features desired in a "perfect" instrument. Foremost demand was for great dependability. Second need indicated was for high trace capacity.

Dependability is achieved by extensive warning and test circuits and by reserve lamps which assure continuous recording in the event of lamp burn-out. Indicators warn immediately of any condition which could cause data loss, while additional circuits permit quick testing of the warning system. Design of the instrument assures reliable operation under the most rigorous environmental conditions.

Standard models provide either 36 or 50 traces. Consolidated's new Series 7-300 Galvanometers provide frequency response flat to 3000 cps. Standard record width of 12″ greatly simplifies record interpretation. Only after several prototypes were successfully tested under actual field conditions did we go into production on the 5-119—the new recording oscillograph leader. Write for Bulletin CEC 1536-X5.

SPECIFICATIONS

TRACE CAPACITY	36 or 50-trace models available
TRACE IDENTIFICATION	repeated, sequential trace breaks
RECORD WIDTH	12″ standard; narrower widths adaptable
RECORD MAGAZINE	removable, integral type; holds 250′ paper or film
RECORD SPEEDS	0.10 to 100 inches per sec. through quick-change gears, instantaneous switch-actuated, 10:1 speed jump
SCANNING SYSTEM	ground-glass screen and adjustable motor-driven polygon mirror; timing lines show on viewing screen
REMOTE OPERATION	accessory control unit with all essential controls & indicators
TIMING PROVISIONS	0.10 and/or 0.01 sec. lines photographed across record
EVENT NUMBERING	high-speed flash system operates as rapidly as one number per sec.
POWER REQUIREMENTS	115 volt, 60 cycle and 26 volt d-c models
INPUT PROVISIONS	all connectors on one rear deck; individual galvanometer plugs
CONTROL PANEL	all controls and indicators on single panel
ACCESSIBILITY	all adjustments can be made from one surface



The 5-119 can be panel mounted vertically with special shockmounts.

Consolidated Engineering

CORPORATION

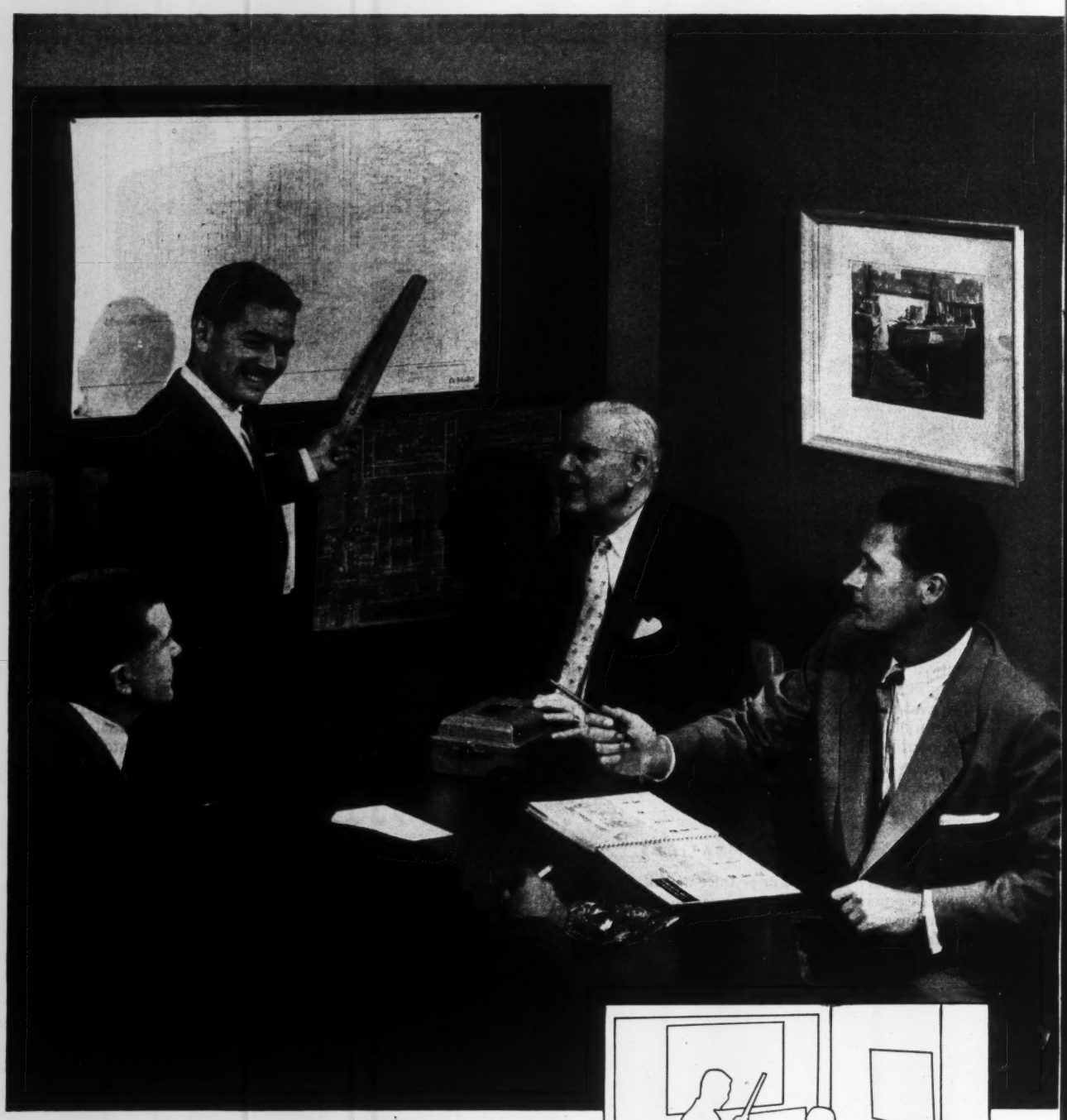
300 North Sierra Madre Villa, Pasadena 15, California

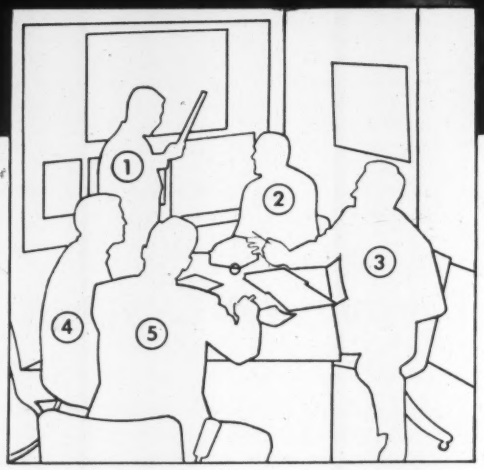
Sales and Service through **CEC INSTRUMENTS, INC.,** *a subsidiary with offices in: Pasadena, New York, Chicago, Washington, D. C., Philadelphia, Dallas.*

analytical instruments for science and industry

Recording Oscillographs

The Type 5-119 is the newest of 7 Consolidated Oscillographs ranging from 9 to 50 channel capacity. These versatile instruments simultaneously record any physical phenomena that can be transformed into electrical impulses. All measurements are obtained in clear, permanent form during the same operational cycle for future detailed analysis.





1. Westinghouse Application Engineer
2. Westinghouse Sales Engineer
3. Chief Engineer
4. Electrical Engineer
5. Production Superintendent

Your motor and control problems are local . . . so is Westinghouse application assistance

Do you put a full team on the field when you tackle a motor and control application problem? Are you cashing in on the know-how of your local staff of Westinghouse application engineers? Take a look at this line-up:

Your local Westinghouse sales engineer has a broad knowledge of all Westinghouse Motors and Controls. He knows their capabilities and limitations. He knows how to match motors and controls for maximum production.

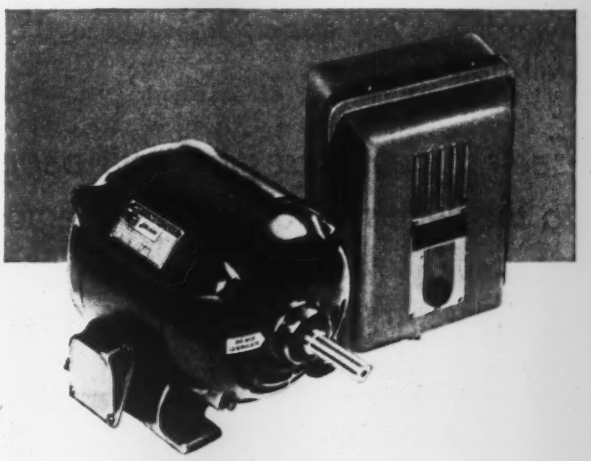
Your local Westinghouse application engineer is equipped to analyze any motor and control problem and then develop the best solution. He can handle any application problem from a simple machine tool to a complete production line.

Your local Westinghouse product engineer is a specialist in one type of motor or control. These men work at the local level but operate from a manufacturing headquarters office.

Enlist the services of these men on your next motor and control application job. Call your local Westinghouse office for further details, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21746

Application engineers work out of 126 Westinghouse offices

Akron 8, Ohio	JEfferson 3165
Albany 5, N. Y.	8-7801
Albuquerque, N. M.	3-1826
Allentown, Pa.	HEmlock 4-5108
Amarillo, Texas	6-7838
Appleton, Wis.	4-4116
Atlanta 2, Ga.	ATwood 1642
Augusta, Maine	3-4571
Baltimore 2, Md.	PLaza 0300
Beaumont, Tex.	4-1481
Binghamton 62, N. Y.	2-6403
Birmingham 3, Ala.	53-2411
Bluefield, W. Va.	3-9131
Boston 10, Mass.	LIberty 2-0600
Bridgeport 8, Conn.	4-0151
Buffalo 3, N. Y.	WAshington 3966
Butte, Mont.	2-2301
Canton 2, Ohio	3-9171
Cedar Rapids, Ia.	7638
Charleston, S. C.	9904
Charleston 1, W. Va.	37-565
Charlotte 1, N. C.	5-3731
Chattanooga 2, Tenn.	7-4361
Chicago 54, Ill.	WHitehall 4-3860
Cincinnati 2, Ohio	GArfield 2250
Cleveland 13, Ohio	CHerry 1-7600
Columbia, S. C.	3-8823
Columbus 15, Ohio	MAin 5527
Corpus Christi, Tex.	3-9237
Dallas 1, Tex.	RIverside 5231
Davenport, Ia.	3-2761
Dayton 2, Ohio	ADams 9153
Denver 2, Colo.	KEystone 8121
Des Moines 8, Iowa	2-0244
Detroit 31, Mich.	TRinity 2-7010
Duluth 2, Minn.	7-1541
El Paso, Tex.	2-5691
Emeryville 8, Cal.	OLympic 2-3770
Erie, Pa.	24-867
Evansville 8, Ind.	5-7146
Fairmont, W. Va.	501
Fergus Falls, Minn.	4250
Fort Wayne 2, Ind.	ANthony 3421
Fort Worth 2, Tex.	FOrtune 4086
Fresno 1, Cal.	4-5097
Gary, Ind.	2-1468
Grand Rapids 2, Mich.	9-3106
Greensboro, N. C.	2-3415
Greenville, S. C.	3-7755
Hammond, Ind.	RUssell 8937
Hartford 3, Conn.	5-0851
Houston 2, Tex.	CHarter 4691
Huntington 1, W. Va.	7146
Indianapolis 9, Ind.	MArket 3301
Jackson, Mich.	2-0519
Jackson, Miss.	6-4839
Jacksonville 6, Fla.	78-6492
Jamestown, N. Y.	8939
Johnstown, Pa.	81-257
Kansas City 6, Mo.	HArrison 7122
Kingsport, Tenn.	3769
Knoxville 8, Tenn.	2-8101
Little Rock, Ark.	4-0367
Los Angeles 17, Cal.	MAdison 6-3881
Louisville 2, Ky.	CLay 0212
Madison 3, Wis.	5-4868
Medford, Ore.	2-8289
Memphis 3, Tenn.	8-8546
Miami 4, Fla.	2-1553
Milwaukee 2, Wis.	DAly 8-1800
Minneapolis 13, Minn.	GRanville 3545
Mobile, Ala.	8-5443
Nashville 3, Tenn.	42-3505
Newark 2, N. J.	MArket 2-0200
New Haven 10, Conn.	5-3191
New Orleans 13, La.	RAymond 8656
New York 5, N. Y.	WHitehall 3-4321
Niagara Falls, N. Y.	9700
Norfolk 10, Va.	5-1639
Oklahoma City 2, Okla.	REgent 6-1633
Omaha 2, Nebr.	HArney 8700
Peoria 3, Ill.	2-5439
Philadelphia 4, Pa.	EVergreen 2-1200
Phoenix, Ariz.	4-3158
Pittsburgh 30, Pa.	ATlantic 1-8400
Portland 4, Ore.	CApitol 1-9151
Providence 3, R. I.	GAspee 1-0818
Raleigh, N. C.	6302
Reading, Pa.	2-0287
Richmond 19, Va.	2-4758
Roanoke 4, Va.	6263
Rochester 7, N. Y.	MOnroe 1635
Rockford, Ill.	2-3452
Rutland, Vt.	3292
Sacramento 14, Cal.	GIlbert 3-6525
Saginaw, Mich.	4-2640
St. Louis 1, Mo.	CEntral 1120
Salt Lake City 1, Utah	5-3413
San Antonio 5, Tex.	GArfield 5114
San Diego 1, Cal.	MAin 8151
San Francisco 8, Cal.	EXbrook 2-5353
Seattle 4, Wash.	MAin 0808
Shreveport, La.	4-5298
Sioux City 4, Iowa	5-7634
South Bend 4, Ind.	3-7167
Spokane 8, Wash.	MAin 3294
Springfield, Ill.	3-1532
Springfield 3, Mass.	6-8373
Syracuse 4, N. Y.	2-1361
Tacoma 2, Wash.	BRoadway 6565
Tampa 1, Fla.	2-7246
Toledo 4, Ohio	GArfield 4625
Trenton 10, N. J.	2-4136
Tulsa 3, Okla.	3-3191
Utica 1, N. Y.	4-1194
Walla Walla, Wash.	5124
Washington 6, D. C.	NAtional 8-8843
Waterloo, Iowa	4679
Watertown, N. Y.	1400
Wheeling, W. Va.	6222-6223
Wichita 2, Kansas	5-2631
Wilkes-Barre, Pa.	3-1144
Williamsport, Pa.	4289
Worcester 8, Mass.	4-2648
York, Pa.	7851
Youngstown 3, Ohio	4-1118



YOU CAN BE SURE...IF IT'S Westinghouse

STUDENT MEMBERS

OF THE ASME

you can get—

A LITTLE CASH!
A LITTLE FUN!
A LITTLE FAME!

HERE'S your opportunity to get that for which you have lacked the wherewithal. There's just one catch — you will have to work for it! If you quit easily — don't read any further. Perhaps a little extra work on your thesis will do the trick.

An engraved certificate signed by the President and Secretary of the Society will accompany each award.

A trip to the Annual Meeting as a guest of the "Old Guard" will be awarded.

Students should consult the Honorary Chairman regarding the rules for these awards. Only papers by single authors will be considered.

Each student must submit his paper to the Vice President of the Region in which his Student Branch is located not later than ***May 15, 1954.***

$150.00

For the best paper by an undergraduate on the subject "The Engineer in Business and Industry." This is the Charles T. Main Award.

An undergraduate must submit his paper for the Charles T. Main Award or Undergraduate Student Award before thirty days after the completion of his undergraduate work.

$25.00

For the best paper on an engineering subject by an undergraduate. This is the Undergraduate Student Award.

$25.00

For the best paper on an engineering subject by a graduate student. This is the Postgraduate Student Award.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

29 West 39th St., New York 18, N. Y.

BIG VALVE, LITTLE EFFORT...

BECAUSE IT'S

A big valve doesn't necessarily mean a hard valve to operate. If it's a Nordstrom, even the biggest valve, in the highest line pressures, can be operated easily by one man, without extension rods or sledges. There are two reasons—

First . . . the Nordstrom pattern of internal lubrication—a practical application of Pascal's law—which jacks the plug hydraulically to turn with low torque.

Second . . . the Nordstrom design, in which a plug revolves *within* the line of flow on a film of lubricant, instead of a disk which must be forcibly wedged into the seat *against* the line of flow.

And, of course, all Nordstrom Valves are lubricant sealed.
Rockwell Manufacturing Company, Pittsburgh 8, Pa.

ROCKWELL Built
Nordstrom Valves
Lubricant-Sealed for Positive Shut-Off

Another ROCKWELL Product

Your automobile will operate without lubrication.
So will most valves, including

NORDSTROM VALVES

But you lubricate your car to reduce wear—to make it easy for metal parts to move against each other without galling—to add to your car's life and cut down on expensive repairs and replacement.

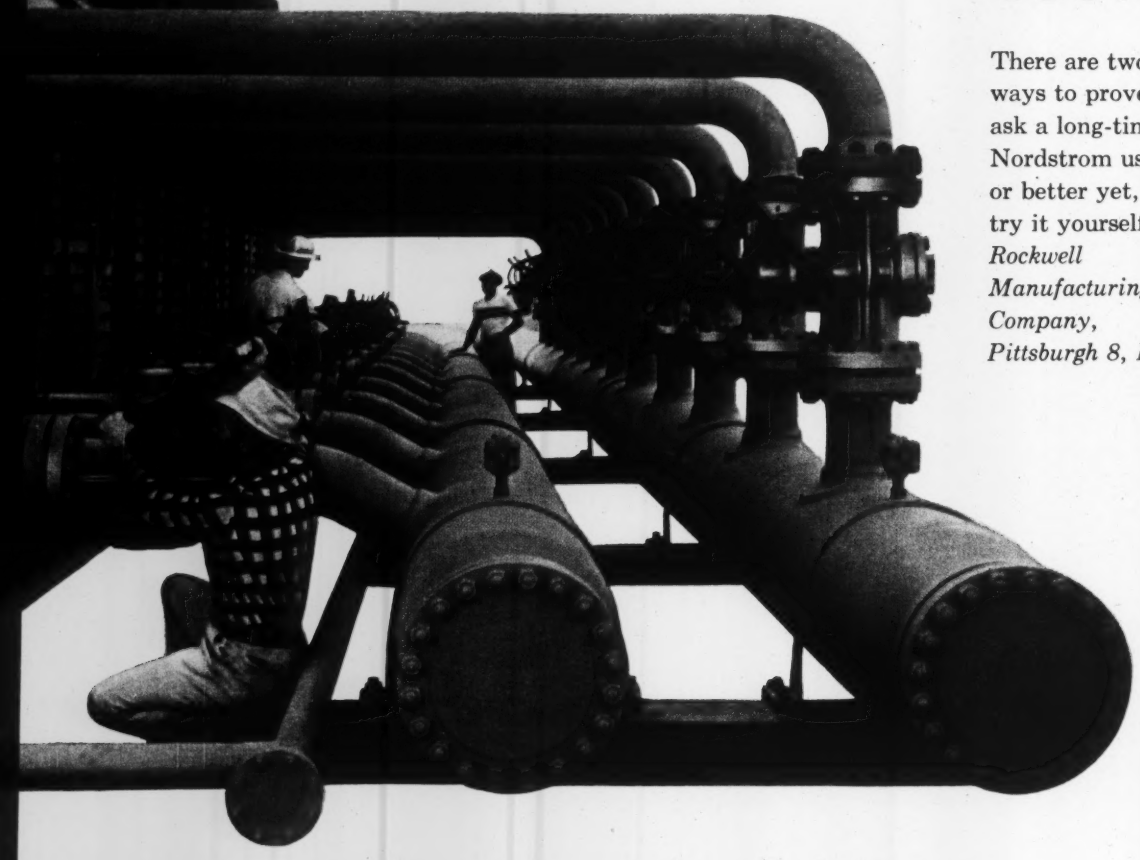
A Nordstrom valve, like your car, is built with an internal lubrication system. A Nordstrom valve

PLUS PERIODIC LUBRICATION

is long run economy. It adds up to less wear, longer trouble-free life, and no hazardous jamming open or shut. And the same lubricant that protects seating surfaces forms a sealing film around the ports so that even hard-to-hold gases and liquids that seep through ordinary valves are tightly checked by Nordstroms.

It pays off, too, to use genuine Rockwell lubricants. Remember, a good product—Nordstrom valves—properly maintained—with Rockwell lubricants

EQUALS LOWER OPERATING COSTS



There are two ways to prove this: ask a long-time Nordstrom user, or better yet, try it yourself.
Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Nordstrom Valves Another Quality **ROCKWELL** Product

Design Your Own Precision Gaging Fixtures

. . . around this Inexpensive Gage Head Cartridge

Measures by .0001" —.00001"

Compact, shock-proof, and moisture-proof, this Brown & Sharpe Gage Head Cartridge No. 953 gives you a simple means for designing high precision into your own gaging fixtures.

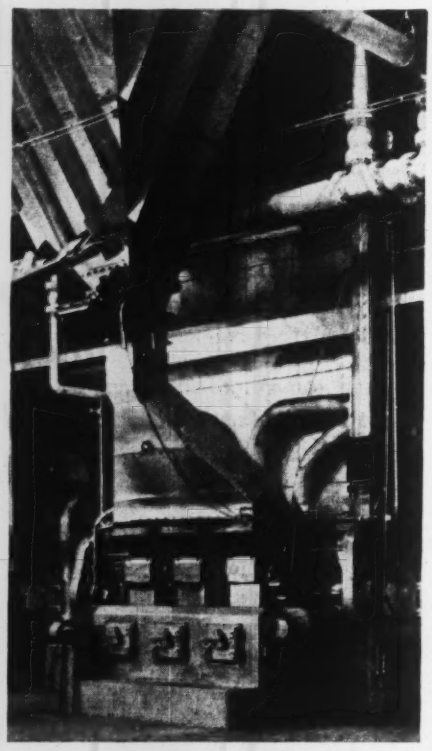
Readings in .0001" to .00001" are taken on the No. 950 Electronic Amplifier. Simply plug the cartridge into the amplifier. You take readings directly from the amplifier's accurately graduated dial . . . only one master required for setting. And you can design cartridges into several fixtures and use the same amplifier on all of them.

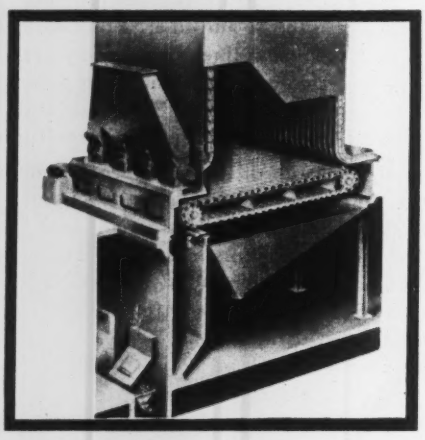
The unique design of the cartridge provides simple adjustment, frictionless movement, adjustable measuring pressure, and wide adaptability to many inspection devices, jigs, fixtures, and machines. Write for detailed Bulletin. Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

BUY THROUGH YOUR LOCAL DISTRIBUTOR

Brown & Sharpe BS

Firite FIRST SPREADER





TYPES OF INDUSTRIES AND INSTITUTIONS SERVED BY HOFFMAN C-A-D STOKERS

Army Air Base
Automotive Manufacturing
Brewing Industry
Chemical Industry
Coal Mining
Drop Forging
Educational
Electrical Products
Federal Power Utilities
Great Lakes Shipping
Harvesting Machinery Manufacturing
Materials Drying Plants
Metal Working Plants
Municipal Plants
Paint Materials Processing
Paper Mills
Pharmaceutical Manufacturing
Plate Glass
Portland Cement Manufacturing
Printing & Office Equipment
Public Utilities
Railroad Shops
Rubber Industry
Smelting & Refining
Sugar Refineries
Textile Industry
Textile Machinery Manufacturing

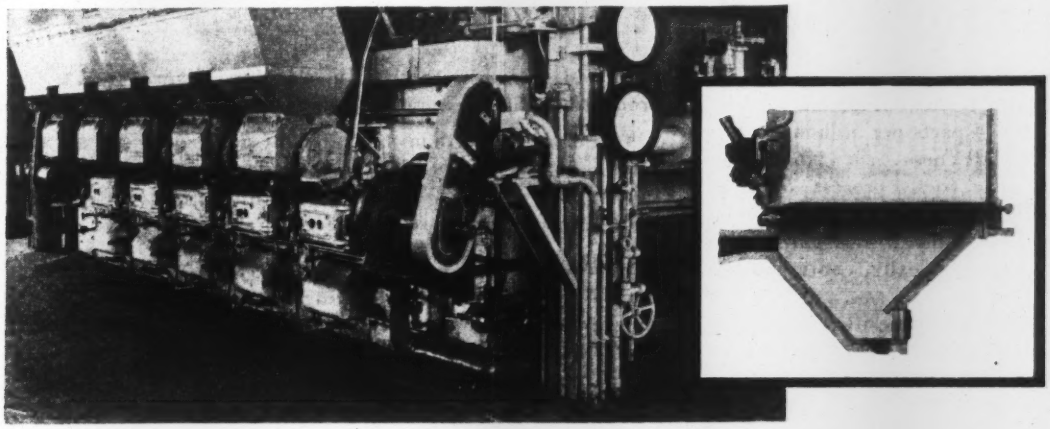
HOFFMAN COMBUSTION ENGINEERING COMPANY

Firite
FIRST SPREADER

HOFFMAN SPREADER STOKERS

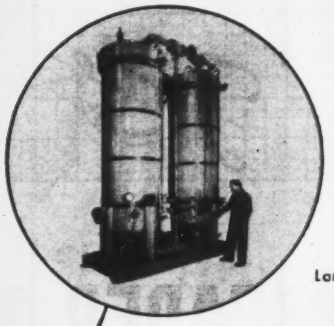
In serving a discriminating clientele for a quarter century, the following are some of the blue chip organizations and the number of boilers equipped with Hoffman Stokers.

One of the largest food products companies	40 stokers
One of the largest railroad companies	18 stokers
One of the largest coal mining companies	24 stokers
One of the largest breweries	13 stokers
One of the largest steamship companies	33 stokers
One of the largest steel corporations and subsidiaries	35 stokers
One of the largest farm machinery companies	19 stokers
One of the largest paper manufacturers	17 stokers
One of the largest mail order houses	20 stokers



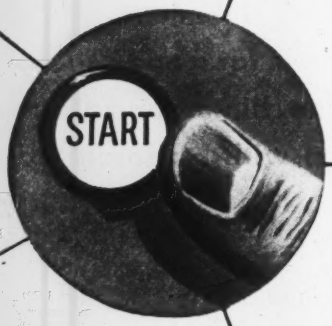
General Offices: **Marquette Bldg. Detroit 26, Mich.**

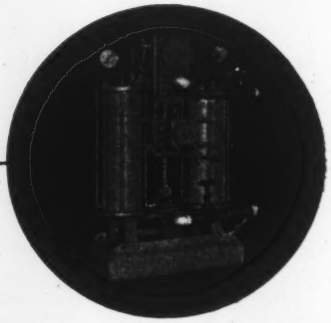
Works: **Fairmont, W. Va., and Detroit, Mich.**



Large liquid hydrocarbon Lectrodryer.

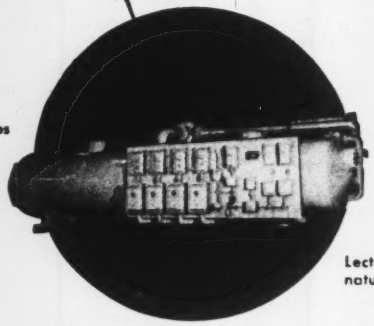
Air Conditioning Lectrodryer.





Small, dual compressed air dryer.

Laboratory Lectrodryer for drying small quantities of gases.



Lectrodryer for drying compressed natural gas.

DRYness . . .

by pressing a button!

Lectrodryers* DRY air and gases to dewpoints as low as −110°F. Moisture content of organic liquids can be reduced to 3 or 4 parts per million.

Wherever you need DRYness . . . in a laboratory jar, on stream in some tricky process, or in a warehouse . . . from atmospheric to 6000 lbs. pressure . . . there's Lectrodryer equipment to give you DRYness automatically, continuously, economically.

Petroleum, chemical, pharmaceutical, plastics and synthetic rubber industries rely on Lectrodryers to provide vital DRYness . . . speed up production . . . protect delicate chemicals.

You can predetermine the constant degree of DRYness you want. Lectrodryer engineers, calling on their 22 years of combating unwanted moisture, can provide reliable assistance.

Data Available—Write for "Because Moisture Isn't Pink," a booklet describing Lectrodryers, their function and application: The Pittsburgh Lectrodryer Corp., 335 32nd St., Pittsburgh, Pa.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

*REGISTERED TRADEMARK U.S. PAT. OFF.

ALL FORGED STEEL

Edward UNIVALVES

Lower Pressure Drop 25-50% with Straight-Thru Flow

As shown photographically here, the streamlined internal contours and the inclined stem construction of the Edward Univalve give straight through flow — which careful laboratory tests have shown to result in pressure drop 25 to 50% lower for Univalves than other globe valve types. Turbulence, too, is greatly lowered by these streamlined contours. And lowering turbulence lengthens valve life by eliminating vibration, the principal cause of wear in small globe valves.

But lower-pressure drop and less turbulence are not the only reasons the Univalve has become an industry standard for tough high pressure, high temperature services. Here are just a few of the benefits which add up to longer life and lower maintenance for this outstanding [illegible]ged Steel Valve.

LONGER PACKING LIFE **through a positive backseat and deep cooling chamber which protects packing in service. Isolation of packing prevents blow-out when repacking under pressure.**

PERFECT ALIGNMENT, EASY DISASSEMBLY **when necessary, through foolproof patented body-bonnet connection.**

EXTRA WEARING SEATING SURFACES— **seat formed by application of continuous ring of Stellite to valve body; Stellite hard-facing applied to alloy steel disk.**

EASY PACKING ADJUSTMENT **with through bolted, accurately guided gland.**

EFFORTLESS SEATING **with Impactor handwheel in sizes 1¼ in. and larger.**

DESIGNED FOR HIGH-PRESSURE, HIGH-TEMPERATURE APPLICATIONS
Two different classes rated for 1500 lb sp at 1023F or 2500 lb sp at 1033F.

AVAILABLE IN A WIDE RANGE OF SIZES
Furnished in 1500 lb or 2500 lb pressure classes in sizes from ½ in. to 2 in.

CHECK VALVES, TOO
Check type Univalves, of spring loaded piston design, have the same basic construction as globe Univalves. Use them together for all welded construction for small pipe lines, eliminating all bonnet joint leakage problems.

IDEAL FOR BLOW-OFF SERVICES
Univalves meet all ASME code requirements for blow-off service and are adaptable for high pressure installations to 3120 psi boiler pressure.

Get the full story on Univalves, ideal all-purpose steel valves—write for Catalog 12G1.

Rod through Univalve demonstrates straight thru flow of this valve.

Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY
1350 West 145th Street, EAST CHICAGO, INDIANA

Another Product

Designed Right

for RUGGED SIMPLICITY and LOW MAINTENANCE

DENISON HydrOILic

PUMP/MOTOR

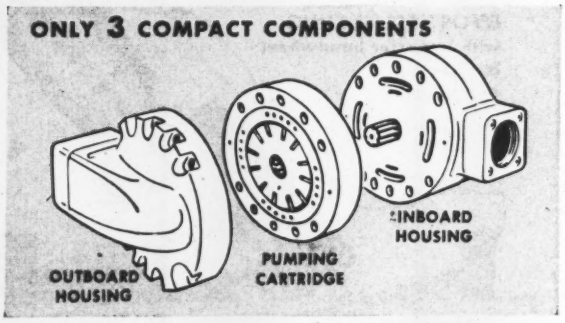
For *Pump* or *Motor* duty at 2000 psi

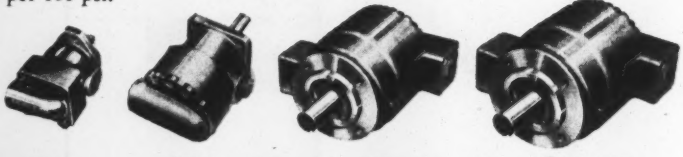
When you add *full hydraulic balance of both rotor and vanes* to design as simple and compact as Denison's rugged PUMP/MOTOR, you can expect smooth-acting efficiency that *holds up* under long, hard, continuous use.

And you get it, in PUMP/MOTORS.

As the name indicates, PUMP/MOTORS meet *either* need—*without alterations of any kind.* They're ready to perform at full efficiency in *either direction* of rotation. With a choice of capacities in each of four basic PUMP/MOTOR sizes, they offer 11 different pumping sizes from 3.0 to 82 gpm—or fluid-motor torque ratings from 13 to 257 pound-inches per 100 psi.

You'll be ahead by filling pump and motor needs in the 2000 psi range with the smooth, balanced action and built-in reliability of Denison's dual-use, bi-directional PUMP/MOTORS. *Write today for Bulletin P-5.*





"The Finest Money Can Buy!"

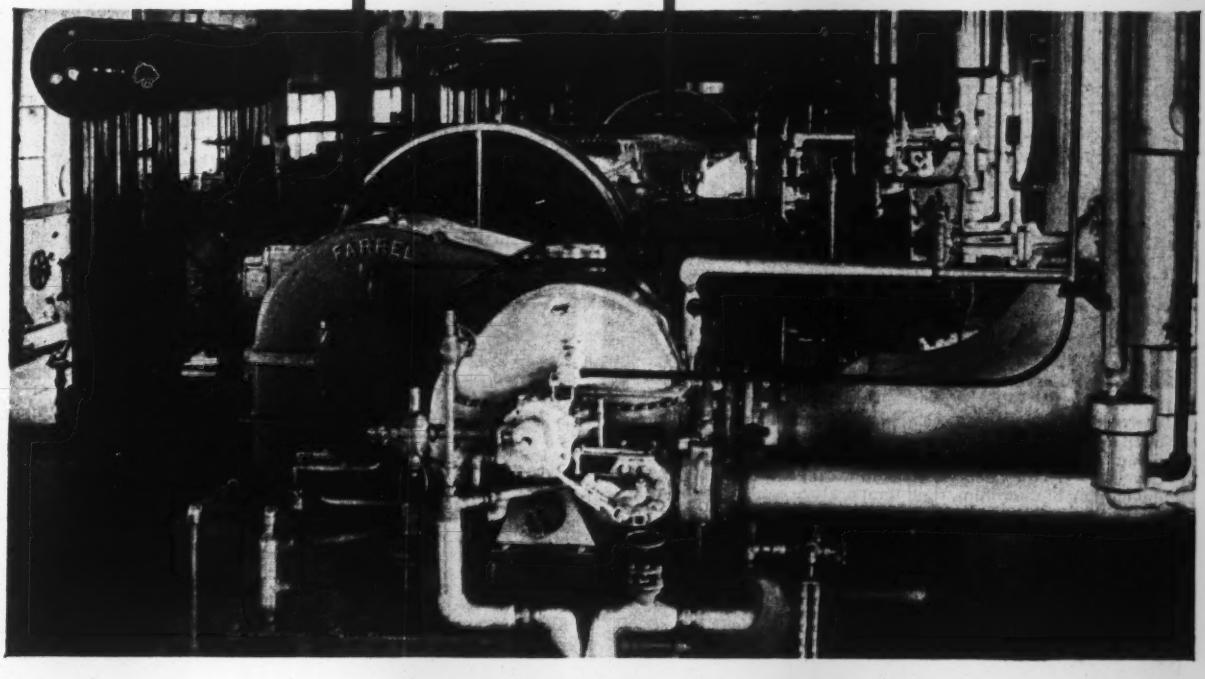
DENISON HydrOILics

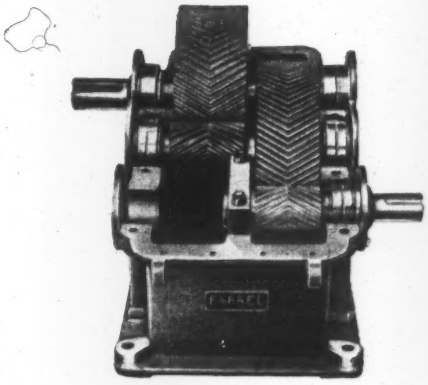
The DENISON Engineering Co.

1189 Dublin Rd., Columbus 16, Ohio

THESE SPEED REDUCERS HANDLE

A TOUGH JOB WITHOUT COMPLAINT





Each of these Farrel® double-reduction gear units is transmitting 920 HP from a turbine to a Cooper-Bessemer M-Line compressor. They are located at the Billings (Montana) refinery of Continental Oil Company.

This is a difficult assignment for any speed reducer. The high-speed operation (4000/300 RPM) really "tests" the design and workmanship of the gear unit.

How well these two Farrel units have performed on this tough job is a matter of record—almost three years of continuous operation, with a minimum of down time for routine inspection and maintenance.

Farrel speed reducers have a number of advantages which account for their outstanding performance records. The quiet, vibration-free operation of the herringbone gears results from extreme acccuracy of tooth spacing, contour and helix angle — qualities inherent in the Farrel-Sykes method of gear generation. Precision manufacture and highest-grade materials contribute to long gear life.

Write for further details of these outstanding units. Ask for a copy of Bulletin 449.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Boston, Akron, Detroit, Chicago, Memphis, Minneapolis, Portland (Oregon), Los Angeles, Salt Lake City, New Orleans

OIL FIELD REPRESENTATIVES

Hercules-Lupfer Engine Sales Co., 124 N. Boston St., Tulsa 1, Okla.
V. W. Osborne, 860-A M & M Building, Houston 2, Texas

FB-814

Farrel-Birmingham ®

How would YOU solve these two problems?

1. STORING BULKY FILES. Engineers examine one of 90 compact microfilm rolls that reduce 70,000 drawings, each about 6 square feet in area, for space-saving storage. In a process developed by the Diebold Manufacturing Co. for continuous developing of microfilm, rigid temperature control is essential in the "fixing" tank. Fenwal THERMOSWITCH® unit keeps the "fixing" solution constantly within one degree of the required 100°F.

Photo courtesy of Hotel Statler, Boston

2. KEEPING DISHES SPOTLESS. For this full-time restaurant job, the Statler Hotels and other leading firms serving the public use Colt Autosan Dishwashing Machines. Fenwal THERMOSWITCH devices in these machines have two functions. The first is to control temperature of washing water. Other units act as low temperature cut-off switches — stopping the conveyor belt if water becomes too cold.

3. A FENWAL THERMOSWITCH CONTROL may solve your problems, too. Its external, single-metal shell expands or contracts *instantly* with temperature changes, making or breaking enclosed electrical contacts. Compact, highly resistant to shock and vibration, Fenwal THERMOSWITCH units have solved hundreds of otherwise costly problems.

4. SEND FOR THIS CATALOG for complete explanation of the unique THERMOSWITCH unit. Also ask for more detailed, illustrated discussions of the problems above. Fenwal engineers will be glad to help you solve your temperature control problems involving heat, humidity, radiant heat, pressure and other variables. **Write Fenwal Incorporated, 510 Pleasant Street, Ashland, Massachusetts.**

Fenwal

THERMOSWITCH®

Electric Temperature Control and Detection Devices

SENSITIVE...*but only to heat*

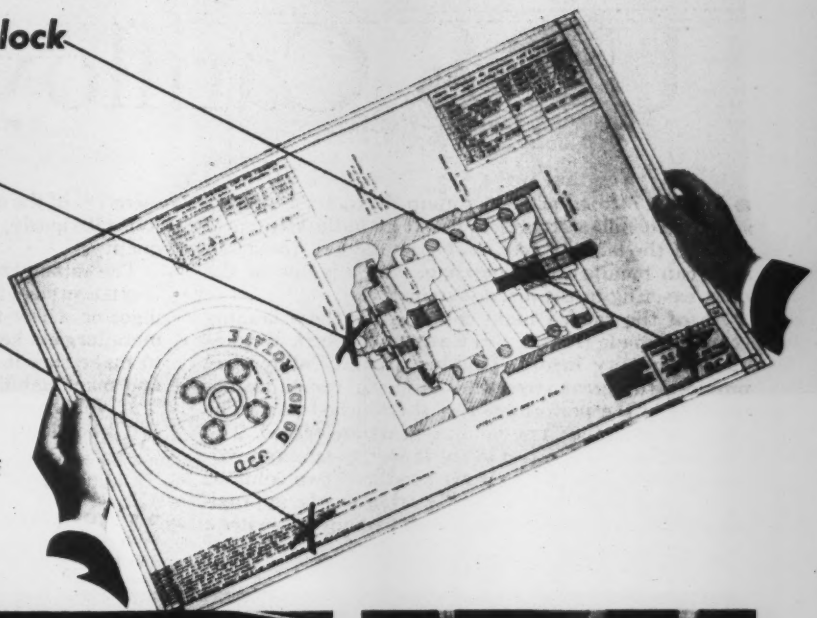
All these changes made

without one line of retracing

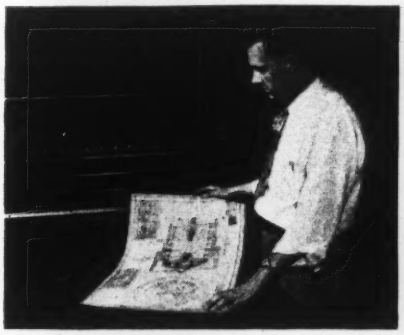
substitute new title block here

transfer design to cloth

delete shop notes and lot numbers



The American Car and Foundry Company, at its Milton, Pa., plant, has to modify hundreds of drawings like the one shown here to meet Army Transportation Corps requirements. Retracing would be much too slow . . . much too expensive. But how else can the job be done? *Kodagraph Autopositive Materials are the welcome answer!*



First—a positive photographic intermediate is made without a negative step by reproducing the original paper drawing on Kodagraph Autopositive Paper. *A fast room-light operation consisting of exposure in a standard print-making machine . . . and processing in standard photographic solutions.* The A.C.F. title block and shop notes are "scissored out" of this print . . . only the essential design remains.

Next . . . the Autopositive cutout of the design area is positioned under a Kodagraph Autopositive Film print, which is a re-usable master containing only the Army Transportation Corps title block. Then this composite is reproduced on a sheet of Kodagraph Autopositive Cloth—the same simple operation as was used previously for processing Kodagraph Autopositive Paper and Film.

Result: a sparkling, extra-durable reproduction comparable to an ink-on-cloth tracing. And the job done—not on the drafting board—but almost entirely in the print-making machine.

Additional time and dollars are saved by using Kodagraph Autopositive Materials to produce print-making masters from specification sheets and blueprints, and protect against the loss of valuable originals.

Kodagraph Reproduction Materials

"THE BIG NEW PLUS" in engineering drawing reproduction

MAIL COUPON FOR FREE BOOKLET

16

Write today for a free copy of "Modern Drawing and Document Reproduction." It gives complete details on the revolutionary line of Kodagraph Materials, which you, or your local blueprinter, can process conveniently, economically.

EASTMAN KODAK COMPANY,
Industrial Photographic Division, Rochester 4, N. Y.

Gentlemen: Please send me a copy of your illustrated booklet giving the facts on Kodagraph Materials.

Name_____ Position_____

Company_____

Street_____

City_____ Zone_____ State_____

Kodak
TRADE-MARK

Every B-36 lands on U·S·S Carilloy Steel

● When 179 tons of B-36 thump down on a landing strip, tremendous stresses are built up in the structural parts of the landing gear. Only the highest quality in steel can handle this tough job, which is one of the most exacting in the aircraft industry.

All of the rugged main columns for these landing gears are made from U·S·S CARILLOY electric-furnace aircraft quality ingots. This high quality alloy steel provides the great strength and shock resistance demanded in the performance of the finished part. The main columns for these landing gears are forged. The original ingot, as shipped to the forger, weighs approximately 37,500 lbs. From it are produced two columns each weighing about 1200 lbs. In other words, approximately 93% of the steel has been removed—with a mere 7% of the original ingot left to do this tremendous job. Obviously, this steel must be of the very best quality.

The same care and skill go into every ton of U·S·S CARILLOY steel that *you* buy, whether it's a giant alloy ingot or a few tons of special steel. Our experienced metallurgists keep a close check on *every* heat of steel to make sure it has the strength, hardness, toughness and machinability that's needed.

If you have a special steel problem, let us know. We'll be glad to help you with it.

U·S·S CARILLOY electric-furnace aircraft quality steel meets every requirement for these vital parts. The precision machining and expert heat treatment they get at Cleveland Pneumatic Tool Company complete the job.

NO ORDINARY STEEL could withstand the huge shock loads imposed on the main landing gears of Convair's giant Air Force B-36 Bomber. The plane has a maximum gross weight of 358,000 lbs., with still higher landing shock loads. U·S·S CARILLOY steel has more than enough impact strength to hold up under this severe punishment.

UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

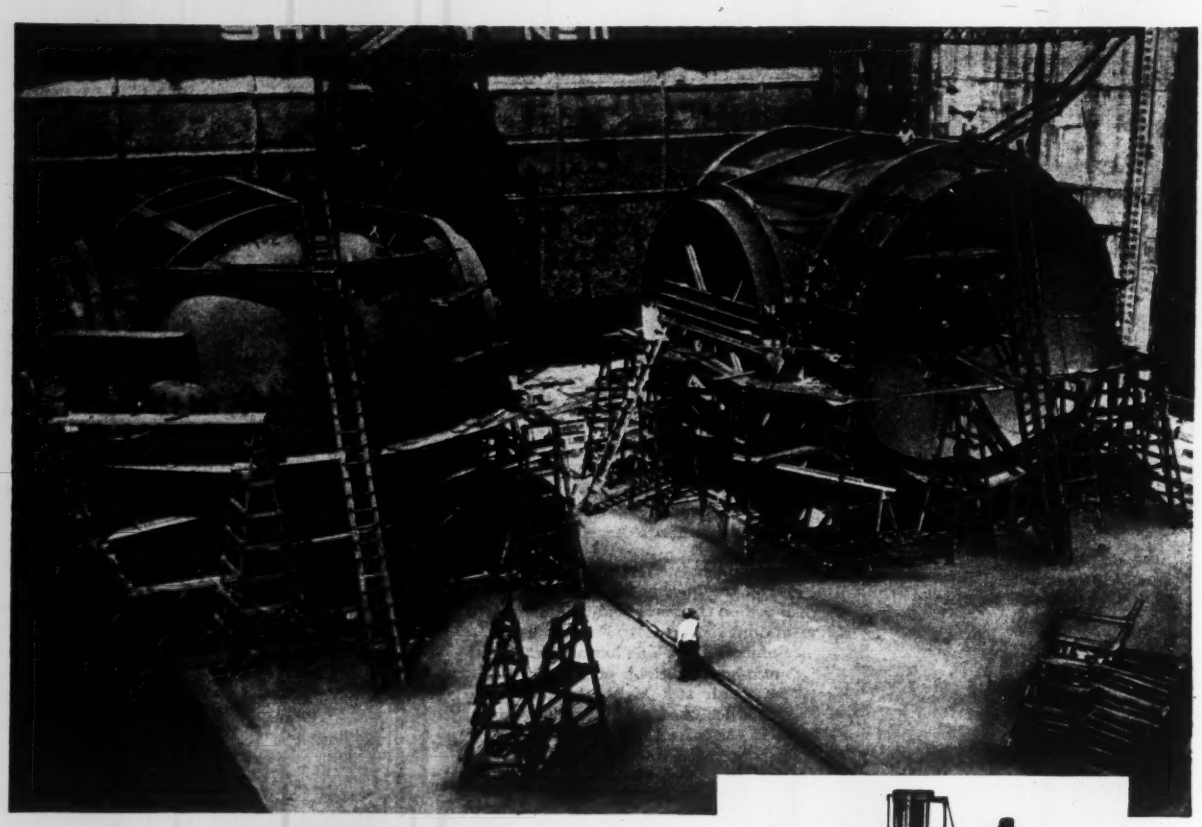
Carilloy USS Steels

ELECTRIC FURNACE OR OPEN HEARTH

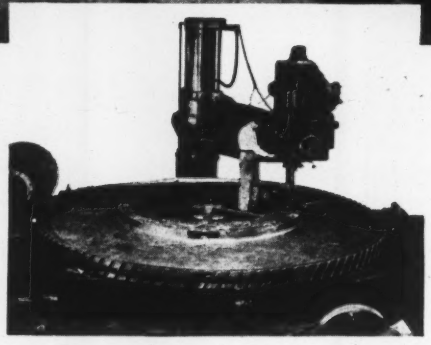
COMPLETE PRODUCTION FACILITIES IN CHICAGO OR PITTSBURGH

3-1215

UNITED STATES STEEL



ASSEMBLING FLOW DIVERSION VALVES of an 8-foot supersonic wind tunnel for the Ames Aeronautical Laboratory of the National Advisory Committee for Aeronautics.



DRILLING A 25-TON FORGING . . . one of 11 alloy steel discs used in one of the two axial flow compressors which Newport News is constructing for the NACA's Ames laboratory.

Man-made Hurricanes

PUSH A BUTTON . . . That's all it will take to accelerate wind up to several times the speed of sound in a new supersonic wind tunnel at the Ames laboratory of the National Advisory Committee for Aeronautics, in Moffett Field, California.

The tunnel is designed to develop new aerodynamic information. Its heart is the "windmaker" . . . two axial-flow compressors which look like a giant tube 50 feet long and 24 feet in diameter, studded with small blades.

Because of the size of this unit, it is significant that the task of building these mammoth compressors was assigned to Newport News.

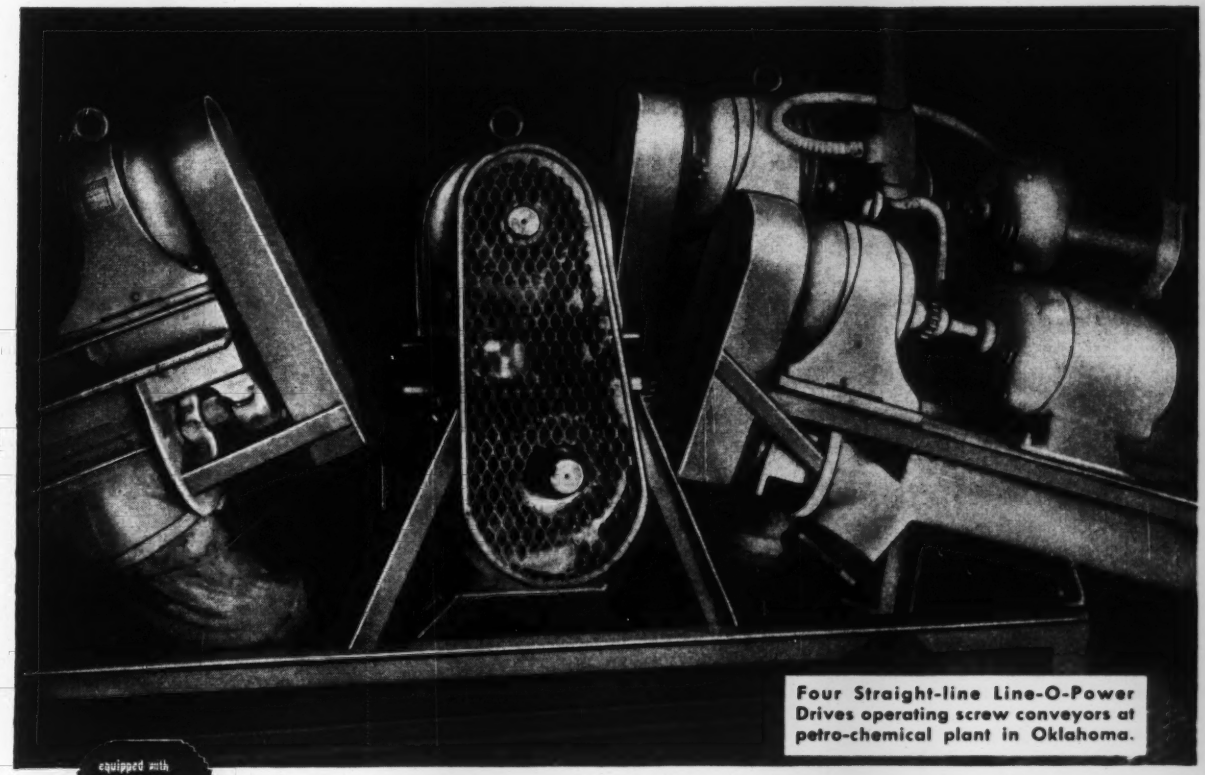
Newport News has also constructed two diversion valves, similar to huge plug valves, for diverting the air flow from one channel of the tunnel to another, as desired.

Large engineering and technical staffs, operating a plant with acres of brass, iron and steel foundries, five huge machine shops and other extensive fabricating facilities, make Newport News an ideal source for large equipment . . . *standard or special in design.*

Products ranging from components of rayon spinning machines to giant 165,000 horsepower hydraulic turbines operating at Grand Coulee, reflect Newport News' high integration of skill and production facilities.

Consult us on equipment for your present or future projects. Write today for your copy of "*Facilities and Products.*"

NEWPORT NEWS SHIPBUILDING AND DRY DOCK COMPANY
Newport News, Virginia



Four Straight-line Line-O-Power Drives operating screw conveyors at petro-chemical plant in Oklahoma.

equipped with FOOTE BROS. Duti-Rated LIFETIME GEARING

This Trademark Stands for the Finest in Industrial Gearing

solve your space and weight problem . . . with LINE-O-POWER*

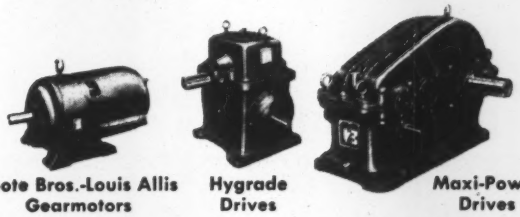
When limited space governs a reducer's size — when weight is a critical factor — LINE-O-POWER is your drive.

Line-O-Power Drives are smaller, lighter, more compact — yet offer almost any reduction you need — because Duti-Rated Lifetime Gearing assures maximum load-carrying capacity in minimum space. Newly-developed Duti-Rated Gears have high hardness, extreme accuracy — permit *big* savings in size and weight.

Longer life — higher efficiency — quieter operation — these are Line-O-Power advantages, brought about by Duti-Rated Lifetime Gearing, unmatched in the industrial gear field.

Sturdy Line-O-Power Drives are available for prompt delivery — in straight-line or right-angle design — with foot or flange mountings — for horizontal or vertical service. Talk over your requirements with the Foote Bros. representative, or write for helpful information.

*REG. U. S. PAT. OFF.



Foote Bros.-Louis Allis Gearmotors | Hygrade Drives | Maxi-Power Drives

FOOTE BROS.

Better Power Transmission Through Better Gears

Foote Bros. Gear and Machine Corporation
Dept. Q, 4545 South Western Boulevard, Chicago 9, Illinois

Please send information about Line-O-Power Drives.

- ☐ Bulletin LPB on Straight-Line Units.
- ☐ Bulletin LWA on Right-Angle Units.

Name.....

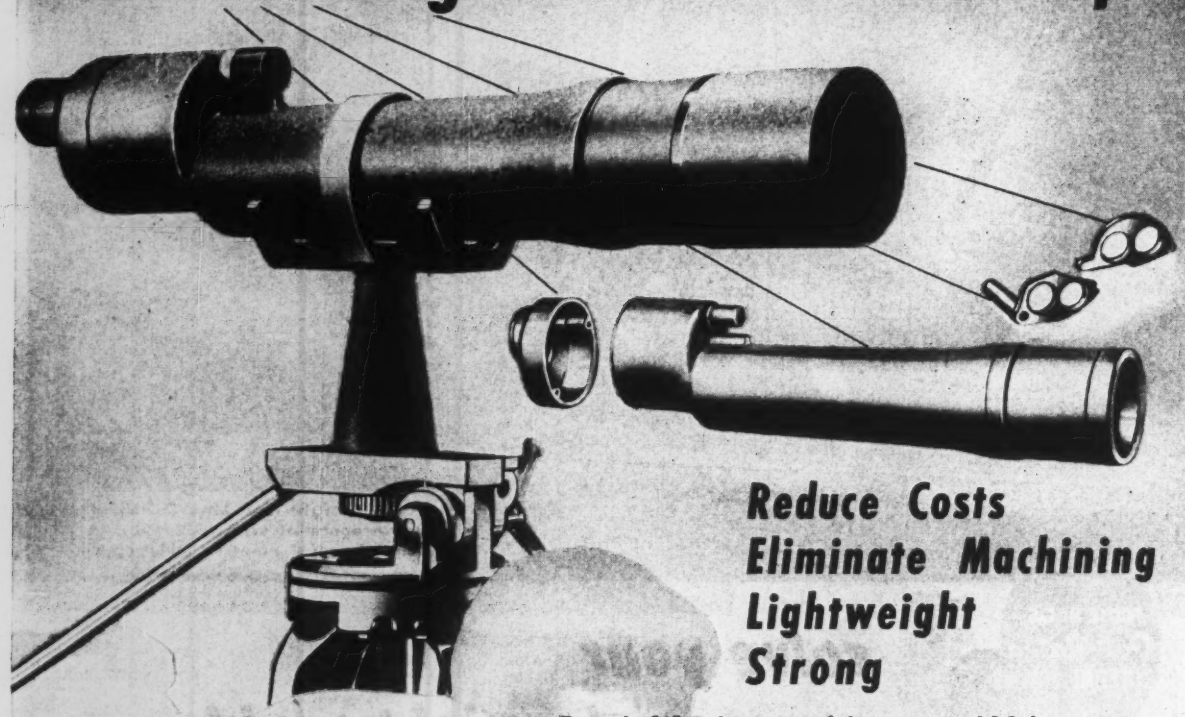
Position.....

Company.....

Address.....

City.....Zone.....State.....

BAUSCH & LOMB selects PARKER Die Castings for 60 MM Telescope



Reduce Costs
Eliminate Machining
Lightweight
Strong

Bausch & Lomb, now celebrating its 100th anniversary, selects Parker as source for quality die castings. The product illustrated is the Bausch & Lomb BALscope Sr. 60 MM spotting scope in wide use as a shooter's spotting scope or, when mounted on a tripod, a telescope for astronomy, sports or bird watching. Parker Die Castings, component parts of this high precision scope, serve to reduce costs by elimination of machining operations. The parts are produced to rigid specifications . . . lightweight and strong.

Consult with Parker on your next die casting requirements. Your action will be mutually profitable.

and when you think of Die Castings THINK OF

Parker White-Metal Company • 2153 McKinley Ave., Erie, Pa.

PARKER ALUMINUM *and* ZINC *Die Castings*

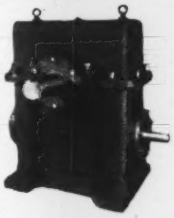
D.O.James

ESTABLISHED 1888

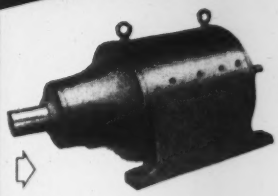
GEARED DRIVES MEET GROWING DEMANDS FOR POWER-SAVING EQUIPMENT IN INDUSTRY

Available in either Horizontal or Vertical Drive

Continuous-tooth Herringbone
Single, Double, Triple Reduction

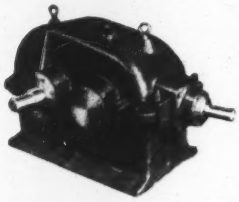


Type "H" Worm Gear



Straight Line Gear Reducer

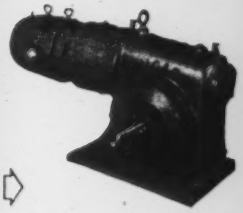
Motorized Reducers



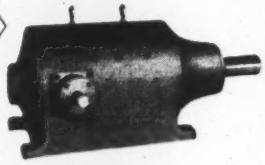
Spiral Bevel Herringbone

Double Worm Gear

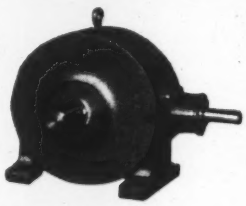
Motor Reducer
— a Packaged Unit



Motorized Worm Gear



Right Angle Gear Reducer



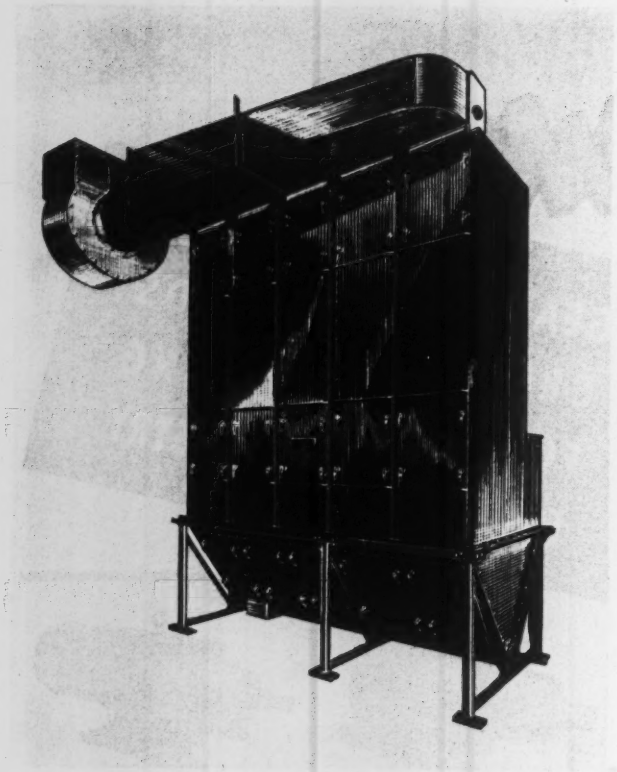
Spiral Bevel Gear

D.O.James Gear Manufacturing Co. is constantly developing and continuing to improve its variety of gear speed reducers — enabling engineers and designers of power-saving equipment to meet and cope with space limitations, horsepower requirements, ratios, location of driven or driving shafts and the type of drive that the many and varied installations require. Catalogs are available containing complete informative engineering data that will assist in the selection of the type of reducer for the specific job to be done.

D.O.JAMES GEAR MANUFACTURING CO.

Since 1888—Makers of Cut Gears, Gear Reducers and Flexible Couplings

1140 W. MONROE STREET • CHICAGO, U. S. A.



Simon Suction Filter Dust Collector manufactured by Safety Car Lighting and Heating Co., Inc.

To reduce maintenance shut-downs

SPONGEX

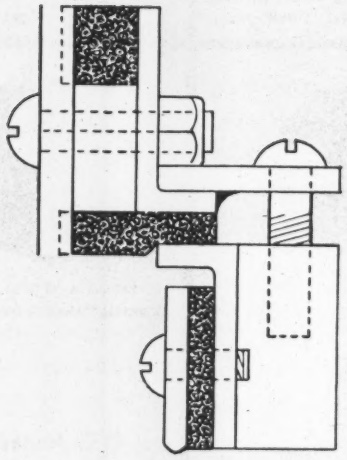
CELLULAR RUBBER

makes longer lasting gaskets

Replacement of even a small gasket on units like this dust collector necessitates a shutdown just as much as a major repair. That's why Spongex cellular rubber gaskets were chosen to seal the intake filter.

Compounded to resist aging, the Spongex seal is long-lasting . . . needs less replacement. Resilient, it forms a firm, tight seal to prevent the escape of the collected dust.

Whether your sealing problem is to keep dust in, or to keep dust out—or if it concerns water, air or temperatures—check with us. Perhaps simple strips cut from economical Spongex Sheet like this or *some* other form of Spongex cellular rubber can do a better job for you.



Cross-section shows how Spongex strips seal filter opening.

SPONGEX® Cellular Rubber

FOR cushioning, insulating, shock absorption, sound and vibration damping, gasketing, sealing, weatherstripping and dust proofing.

THE SPONGE RUBBER PRODUCTS COMPANY 601 Derby Place, Shelton, Conn.

Remember the trade marks "tt" and "TUBE-TURN" are applicable only to products of TUBE TURNS, INC.

Available in all piping materials!

ALLOY OR NON-FERROUS PIPING is often the answer to problems of contamination, corrosive action, severe pressures and temperatures, or cyclic operation. You can obtain TUBE-TURN Welding Fittings and Flanges of stainless steels, nickel and nickel-base alloys, copper and copper-base alloys, aluminum and aluminum-base alloys, and newest of all, titanium. For good service in welding fittings, in carbon steels, or in alloy or non-ferrous metals, call your nearby TUBE TURNS' Distributor. He's ready to serve you from industry's most complete line.

The Leading Manufacturer of Welding Fittings and Flanges

TUBE TURNS, INC. LOUISVILLE 1, KENTUCKY

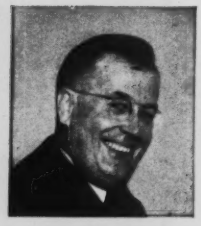
DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Chicago • Houston • Tulsa • San Francisco • Los Angeles • Denver • Atlanta • Dallas • Midland, Texas

Subsidiaries: TUBE TURNS OF CANADA LIMITED, CHATHAM, ONTARIO • PENNSYLVANIA FORGE CORPORATION, PHILADELPHIA, PA.

ENGINEERING SERVICE

TUBE TURNS' *Engineering Service*

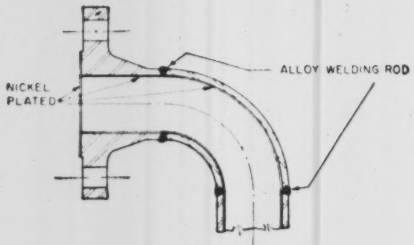
can help you cut cost of corrosion-resistant piping



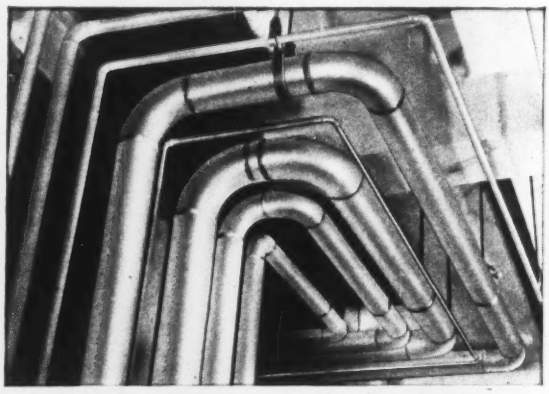
G. A. GAUM is one of TUBE TURNS' Engineering Service Division men spending a great deal of time in the field obtaining performance data that contributes to improved piping technology.

THE COST of corrosion-resistant piping can often be minimized by the use of standard carbon steel piping *plated* on the inner surface with such materials as nickel, copper, etc. In atomic energy plants, nickel-plated piping in sizes through 42" is giving satisfactory service, and has substantially reduced original cost. The method is also applicable to many industrial processes where corrosion resistant materials are specified.

Such plating is generally .008" thick, and can be applied in heavier thicknesses where desirable. You can obtain recommendations on preferred plating sources, proper welding techniques and rods from TUBE TURNS' Engineering Service—always ready to help you with special piping problems.



Installation procedure for nickel plated welding fittings and flanges.



These welded aluminum lines, fabricated with TUBE-TURN Welding Fittings, are permanently leakproof, reducing maintenance to a minimum. Since Tube Turns, Inc. offers the world's broadest line of welding fittings and flanges, all necessary types of welding fittings for any job can be obtained from one reliable source.

Dimensional accuracy of TUBE-TURN Welding Fittings speeds fabrication in the shop or in the field. True circularity and uniform wall thickness assure perfect alignment. Each TUBE-TURN welding fitting is individually examined by skilled inspectors for accuracy.

TUBE TURNS, INC., Dept. F-9
224 East Broadway, Louisville 1, Kentucky

Please send me free copy of:

- ☐ Special Alloys
- ☐ Pipe and Fitting Materials
- ☐ Stainless Steel Welding Fittings and Flanges
- ☐ Design Properties of Pipe

Your Name _____

Address _____

City _____ *State* _____

Position _____ *Company* _____

DISTRICT OFFICES

New York	Tulsa
Philadelphia	San Francisco
Pittsburgh	Los Angeles
Chicago	Atlanta
Houston	Denver

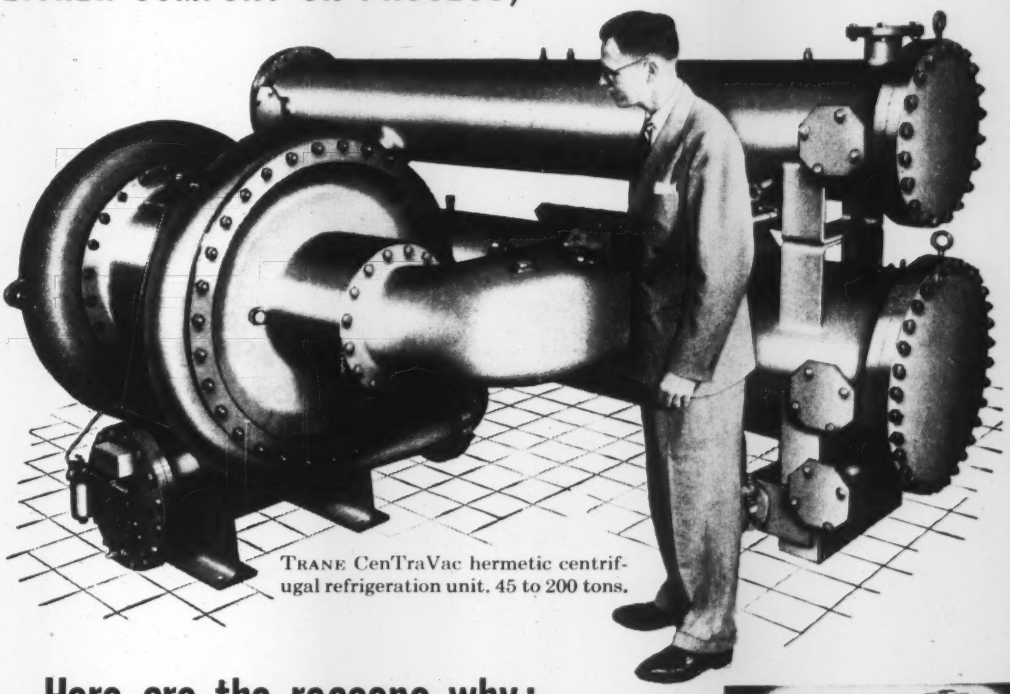
"tt" and "TUBE-TURN" Reg. U. S. Pat. Off.

TUBE TURNS, INC.

LOUISVILLE 1, KENTUCKY

Here's the low cost way to get chilled water

(FOR EITHER COMFORT OR PROCESS)



TRANE CenTraVac hermetic centrifugal refrigeration unit. 45 to 200 tons.

Here are the reasons why:

1. Brings big-job economies to all installations . . . for the first time, the proved money-saving advantages of centrifugal compressors are available to small and medium-sized jobs . . . down to 45 tons.

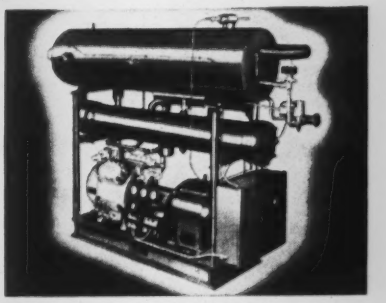
2. Complete in one package . . . self-contained . . . all components are perfectly integrated, therefore operate more efficiently (at less cost).

3. Easier to install . . . light, compact . . . needs no special base, only simple water and electrical connections. Saves on installation costs.

4. Completely automatic . . . needs no special attention . . . a push-button operation. Frees attendant for other duties.

5. Fewer moving parts mean fewer breakdowns, less maintenance. No shaft seals or gear boxes at all. Only *one* major moving part.

6. Built-in automatic capacity control permits operation down to 10% of rated capacity . . . saves power.



Here's the answer for 10 to 50-ton jobs! A completely packaged water chiller . . . ready to install. The new TRANE Cold Generator comes completely assembled, wired, piped, refrigerant-charged.

TRANE CenTraVac cuts chilled water costs 6 ways

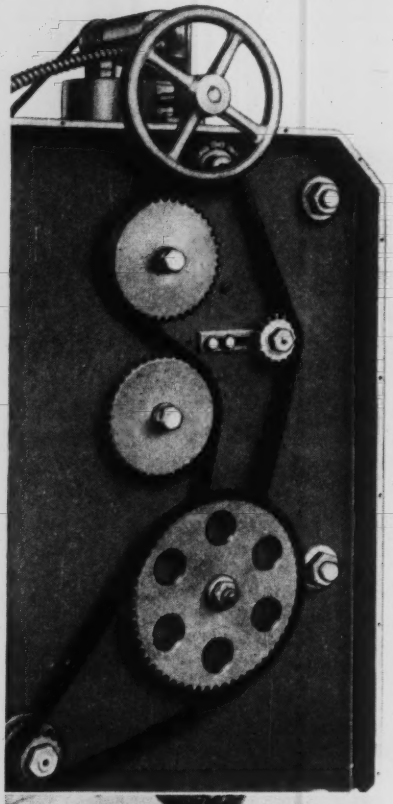
The Trane Company, La Crosse, Wis. • East. Mfg. Div., Scranton, Penn. • Trane Co. of Canada, Ltd., Toronto • 87 U.S. and 14 Canadian Offices

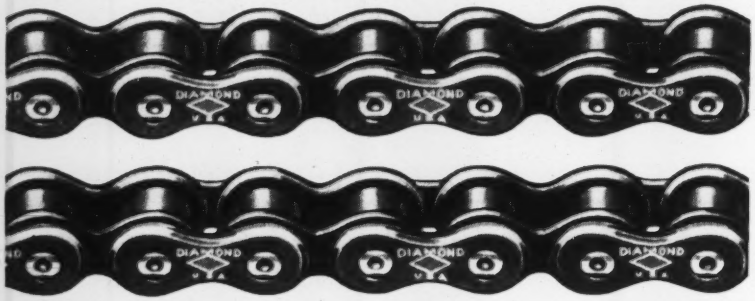
MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING AND VENTILATING EQUIPMENT

Only Roller Chains

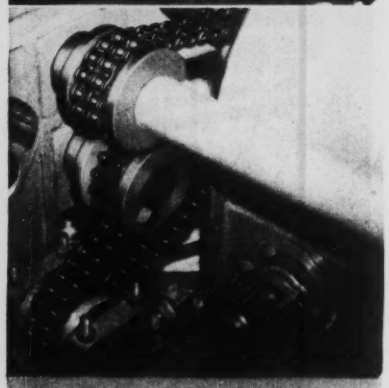
Can Offer Such Wide Adaptability

—And "Diamond" Roller Chains Offer Time-Proven Performance





- √ *Both Sides of Chain are Alike*
- √ *Operate Any Number of Shafts*
- √ *Simplify Selection of Shaft Locations*
- √ *Smooth, Slipless Operation*
- √ *Maintained Speed Ratios*
- √ *Wide Adaptability*



PITCH HOLE PREPARATION

Maximum rigidity of links insured by special pitch hole preparation for 100% effective bearing area of pin and bushing. Longer life, smoother operation.

SHOT-PEENING SINCE 1944

Diamond Chain has long recognized that certain types of internal stressing of chain parts would increase fatigue resistance. To this end, link plates have been specially processed and chain rollers and other parts have been shot-peened since 1944.

• Diamond Roller Chains engage sprockets equally well on either side, providing the design engineer with great flexibility as to the number of shafts driven from one driver, the driven shaft locations and direction of rotation. Size of sprockets determine speeds as desired.

Our engineering staff is ready to make recommendations.

DIAMOND CHAIN COMPANY, Inc.

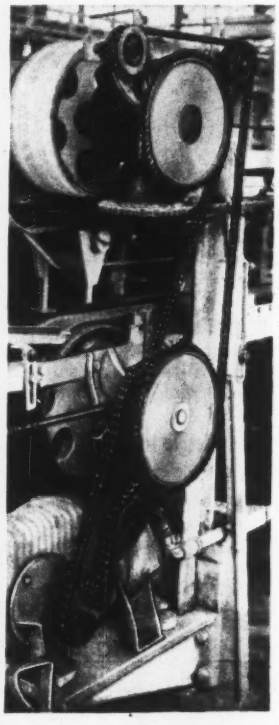
Where High Quality is Tradition

Dept. 413, 402 Kentucky Avenue, Indianapolis 7, Ind.

Offices and Distributors in All Principal Cities

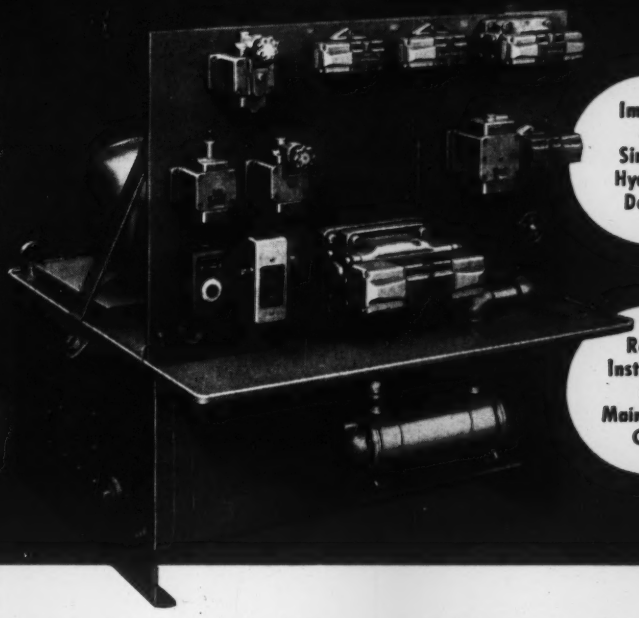
Refer to the classified section of your local telephone directory under the heading CHAINS or CHAINS-ROLLER

DIAMOND **ROLLER CHAINS**



It Takes MORE than a Collection of Parts

To Make A VICKERS CUSTOM BUILT POWER UNIT



Improve and Simplify Hydraulic Design

Reduce Installation and Maintenance Costs

A Vickers Custom Built Power Unit is much more than a collection of parts . . . just as the machines you build are more than the castings, shafting, gears, motors, etc. that go into them.

The Vickers Unit is designed and built with the "know-how" obtained during more than a quarter century of experience in practically every kind of hydraulic operation, plus a thorough understanding of your needs. It is built exactly to your individual requirements. All necessary pumps, valves, intermediate piping, oil reservoir, motors, controls, etc., are in one compact and self-contained "package". It includes all needed hydraulic accessories such as oil filters, air cleaners, oil level gauges, fittings, etc. Hydraulic connections may be grouped in a conveniently located manifold.

The result is simplification of hydraulic design and important savings in installation and maintenance costs. Vickers undivided responsibility for the entire hydraulic control system is another important advantage to both the machine builder and his customer. • Write for new Bulletin 52-45.

VICKERS Incorporated
DIVISION OF THE SPERRY CORPORATION
1500 OAKMAN BLVD. • DETROIT 32, MICH.

Application Engineering Offices:
ATLANTA • CHICAGO (Metropolitan) • CINCINNATI • CLEVELAND
DETROIT • HOUSTON • LOS ANGELES (Metropolitan) • NEW YORK
(Metropolitan) • PHILADELPHIA (Metropolitan) • PITTSBURGH
ROCHESTER • ROCKFORD • SEATTLE • TULSA
WASHINGTON • WORCESTER

6053

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

Just Issued!

The New 1954 MECHANICAL CATALOG

Coming your way, housed in a new cover designed for ease in recognition is your new 1954 MECHANICAL CATALOG. More than 4,500 manufacturers co-operated in bringing you up-to-the-minute information on 6,000 products in over 50,000 listings, plus 342 pages of illustrated details to provide the specific data you need to guide the selection of engineered products.

Cross indexed to save valuable time in locating suppliers of anything from absorbers to zinc oxides, MECHANICAL CATALOG has proved its usefulness to engineers since 1911.

If you haven't already reserved your copy, do so now, the supply is limited.

Another service by ASME for its members!

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 West 39th Street, New York 18, N. Y.

Mr. C. E. Davies, Secretary

Please send me a copy of the 1954 MECHANICAL CATALOG. I have not previously requested a copy of the 1954 edition.

NAME.....

TITLE.....

COMPANY.....

BUSINESS ADDRESS.....

.....

Meet the man you can call with confidence to solve your thermal insulation problems

To insulate outdoor tanks with complete weather protection, these skilled J-M applicators follow a specification developed by Johns-Manville. Here they are fastening J-M Asbestocite* Sheets over J-M Zerolite* Insulation. J-M 85% Magnesia Insulation is also widely used for this type of equipment

He is your J-M Insulation Contractor... the man with the world's most complete insulation engineering service

"Insulation is no better than the man who applies it." Today, with rising fuel and maintenance costs, it is especially important to place your insulation job in skilled hands. The scientific application of J-M quality insulations by J-M Insulation Contractors will assure you of the maximum return on your insulation investment for years to come. Moreover, you get undivided responsibility for *all* your insulation requirements.

1. You get dependable materials—Johns-Manville manufactures a complete line of insulations for every service temperature from minus 400F to plus 3000F. From them your J-M Insulation Contractor can select the right insulation for the most dependable service on your job. To develop new and improved insulation materials Johns-Manville maintains the J-M Research Center—largest laboratory of its kind in the world.

2. You get dependable engineering—For 95 years Johns-Manville has been accumulating insulation engineering experience. J-M Insulation Engineers are called upon to solve insulation problems of every type and magnitude, in every industry. Since your J-M Insulation Contractor works closely with J-M Insulation Engineers, he brings to *every* job a high degree of training, skill and experience.

3. You get dependable application—Johns-Manville has set up a nationwide organization of J-M Insulation Contractors to serve you. These Contractors maintain staffs of insulation engineers as well as skilled mechanics thoroughly trained in J-M's proved application methods. You can have absolute confidence in their ability to apply J-M insulations correctly for trouble-free performance.

For further information and the name of your J-M Insulation Contractor, write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ont.

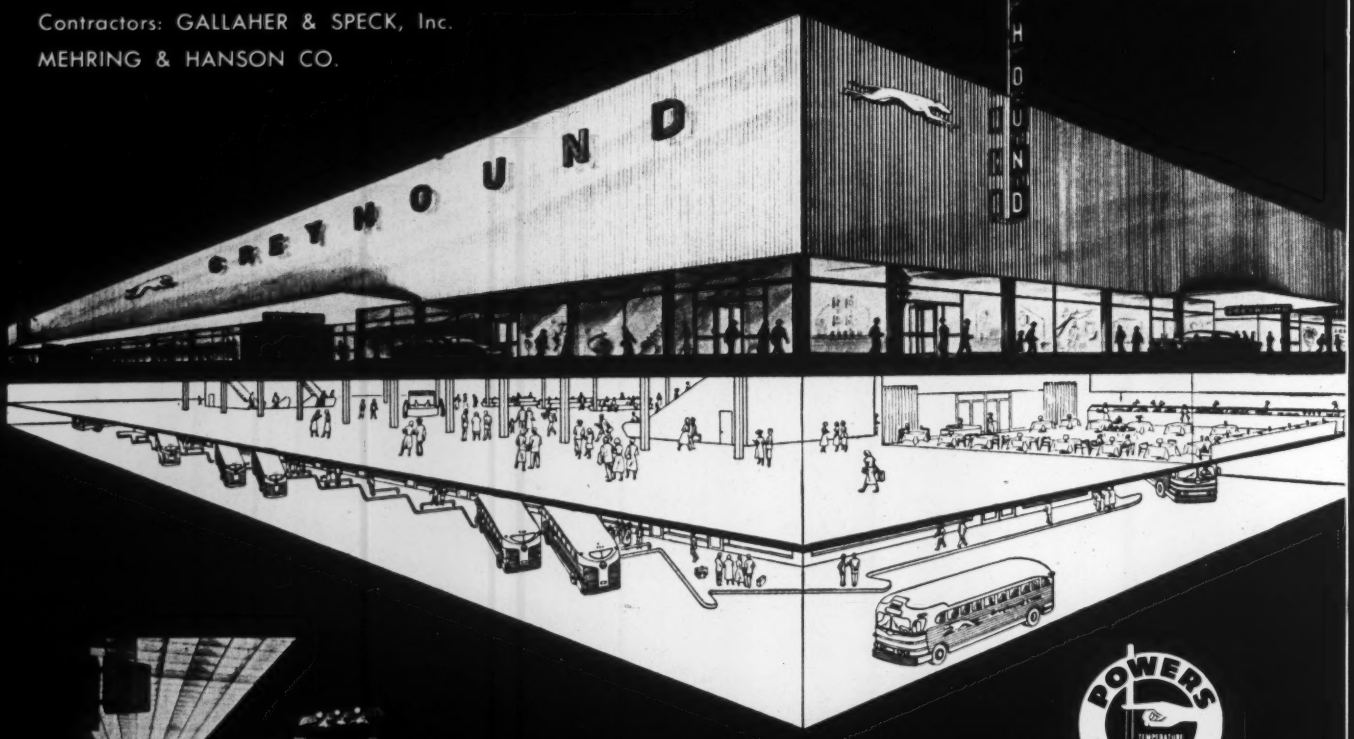
*Reg. U. S. Pat. Off.

Johns-Manville *FIRST IN* INSULATION

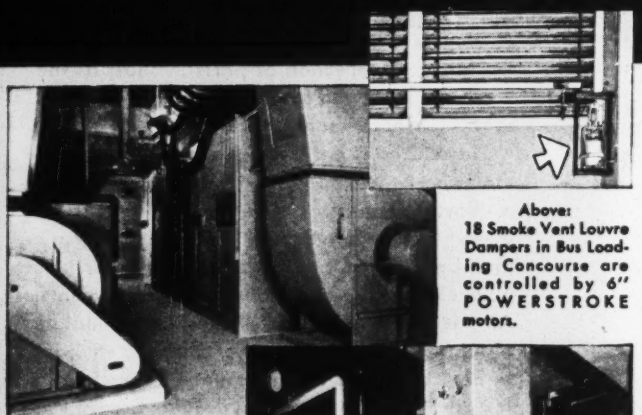
MATERIALS • ENGINEERING • APPLICATION

Air Conditioned Comfort

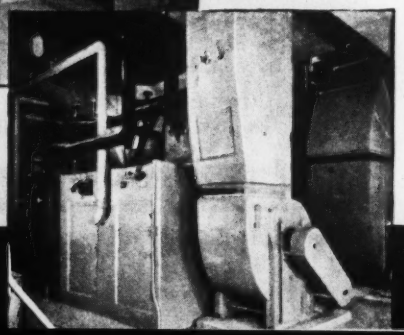
Architects and Engineers: SKIDMORE, OWINGS & MERRILL
Contractors: GALLAHER & SPECK, Inc.
MEHRING & HANSON CO.



POWERS CONTROL
TEMPERATURE AND HUMIDITY



Above:
18 Smoke Vent Louvre Dampers in Bus Loading Concourse are controlled by 6" POWERSTROKE motors.

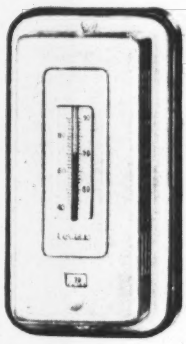


Some of the more than 20 supply and exhaust fans with a total capacity of 500,000 cfm which are Powers controlled.

in Biggest Privately Owned Bus Terminal

is assured by a

POWERS PNEUMATIC SYSTEM OF *Control*



Type D Thermostat

Greyhound Corporation's new up-to-the-minute $10 million bus terminal in Chicago is completely air conditioned. The two million passengers yearly, estimated to use this building, will find every modern convenience and comfort.

On the top two levels, is a public parking space for 500 autos. On the street level and the waiting room level are 13 stores and shops, 7 restaurants and other spaces, which are air conditioned and Powers controlled.

On the bottom level is the Bus Loading Concourse with 31 platforms for arriving and departing buses. Its ventilating system has a capacity of 180,000 cfm which creates a continuous 5 mph breeze. Here 18 Smoke Vent Louvre Dampers are controlled by 6" POWERSTROKE motors. In case of emergency the dampers can be opened by 3 manually operated positive switches each strategically located in a glass covered cabinet.

Domestic Hot Water Supply for the building is furnished by steam heated storage heaters controlled by Powers No. 11 Temperature Regulators. Shower Baths thruout the building are each regulated by a Powers Thermostatic Water Mixer.

Experience gained by Powers here and in many other important large and small buildings will be helpful to you. Next time a temperature or humidity control problem arises, contact POWERS nearest office. There's no obligation.

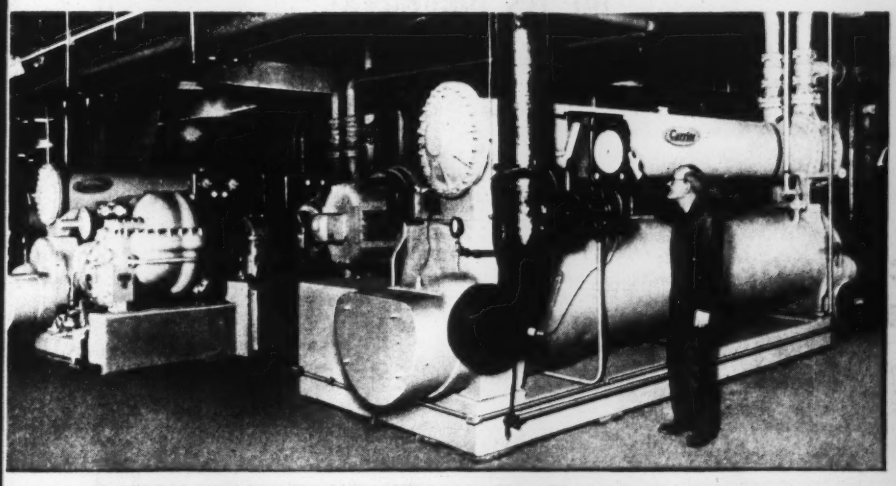
THE POWERS REGULATOR CO.

Skokie, Ill. • Offices in Over 50 Cities in the U.S.A., Canada and Mexico

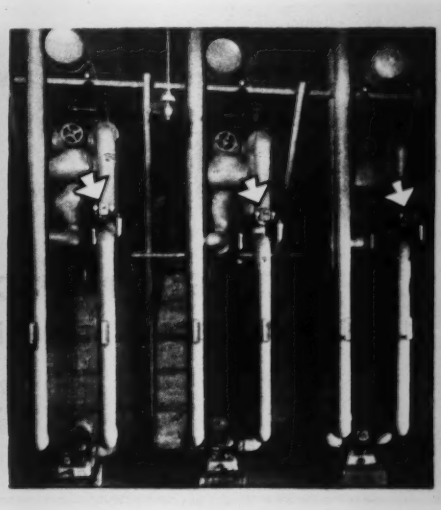
See Your Phone Book

OVER 60 YEARS OF AUTOMATIC TEMPERATURE CONTROL

(b16)



Mr. Henry Burckert, Chief Engineer inspecting one of the two Powers Series 100 Recording-Controllers on two Centrifigul Refrigerating Compressors (610 Ton Cap.) supplying chilled water for air conditioning.



Nine Powers ACCRITEM Regulators above operate FLOWRITE diaphragm valves which control chilled water in summer and hot water in winter supplied to individual coils throughout the building.

Just Issued!

The New 1954 MECHANICAL CATALOG

Coming your way, housed in a new cover designed for ease in recognition is your new 1954 MECHANICAL CATALOG. More than 4,500 manufacturers co-operated in bringing you up-to-the-minute information on 6,000 products in over 50,000 listings, plus 342 pages of illustrated details to provide the specific data you need to guide the selection of engineered products.

Cross indexed to save valuable time in locating suppliers of anything from absorbers to zinc oxides, MECHANICAL CATALOG has proved its usefulness to engineers since 1911.

If you haven't already reserved your copy, do so now, the supply is limited.

Another service by ASME for its members!

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 West 39th Street, New York 18, N. Y.

Mr. C. E. Davies, Secretary

Please send me a copy of the 1954 MECHANICAL CATALOG. I have not previously requested a copy of the 1954 edition.

NAME.....

TITLE.....

COMPANY.....

BUSINESS ADDRESS.....

.....

Meet the man you can call with confidence to solve your thermal insulation problems

To insulate outdoor tanks with complete weather protection, these skilled J-M applicators follow a specification developed by Johns-Manville. Here they are fastening J-M Asbestocite* Sheets over J-M Zerolite* Insulation. J-M 85% Magnesia Insulation is also widely used for this type of equipment

He is your J-M Insulation Contractor... the man with the world's most complete insulation engineering service

"Insulation is no better than the man who applies it." Today, with rising fuel and maintenance costs, it is especially important to place your insulation job in skilled hands. The scientific application of J-M quality insulations by J-M Insulation Contractors will assure you of the maximum return on your insulation investment for years to come. Moreover, you get undivided responsibility for *all* your insulation requirements.

1. You get dependable materials—Johns-Manville manufactures a complete line of insulations for every service temperature from minus 400F to plus 3000F. From them your J-M Insulation Contractor can select the right insulation for the most dependable service on your job. To develop new and improved insulation materials Johns-Manville maintains the J-M Research Center—largest laboratory of its kind in the world.

2. You get dependable engineering—For 95 years Johns-Manville has been accumulating insulation engineering experience. J-M Insulation Engineers are called upon to solve insulation problems of every type and magnitude, in every industry. Since your J-M Insulation Contractor works closely with J-M Insulation Engineers, he brings to *every* job a high degree of training, skill and experience.

3. You get dependable application—Johns-Manville has set up a nationwide organization of J-M Insulation Contractors to serve you. These Contractors maintain staffs of insulation engineers as well as skilled mechanics thoroughly trained in J-M's proved application methods. You can have absolute confidence in their ability to apply J-M insulations correctly for trouble-free performance.

For further information and the name of your J-M Insulation Contractor, write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ont.

*Reg. U. S. Pat. Off.

Johns-Manville *FIRST IN* INSULATION

MATERIALS • ENGINEERING • APPLICATION

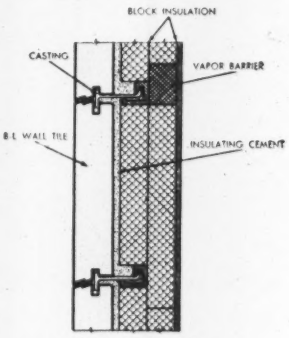
ONE . . . SOURCE

materials • engineering erection help for refinery vessel linings

SUSPENDED LININGS

All of the important features of suspended construction—inherent in the B-L design—are included in Bigelow's abrasion-resistant linings for bead catalyst units.

1. Horizontal tile joints slope downward to resist bead infiltration.
2. Arc-type support castings provide base for vapor barriers.
3. Castings are 1400° F. high-temperature metal.
4. Linings are special abrasion-resistant refractories.
5. Tile, backed up by insulation, minimized heat loss.
6. No cumulative loading or expansion.

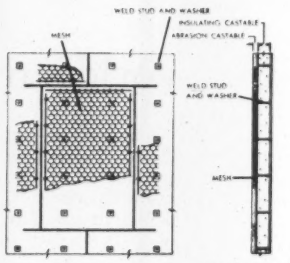


SECTION THROUGH

CASTABLE LININGS

B-L provides a source for a *complete* job—engineering, materials, complete erection—of pneumatically-applied castable linings for fluid catalyst units, cyclones, pipes, stacks and ducts.

1. Insulating castable SK-7 acts as a vapor barrier.
2. Abrasion-resistant castable KS-4 resists wear.
3. Mesh and mesh supports hold castable firm.
4. Design provides for panel expansion.
5. One source dependability assures continuous "on stream" service.



TYPICAL MESH INSTALLATION SECTION THROUGH

Remember, you can co-ordinate suspended construction with castable for an efficient installation. Suspended construction is ideal for oil heaters, too. Write today.

BIGELOW-LIPTAK *Corporation*

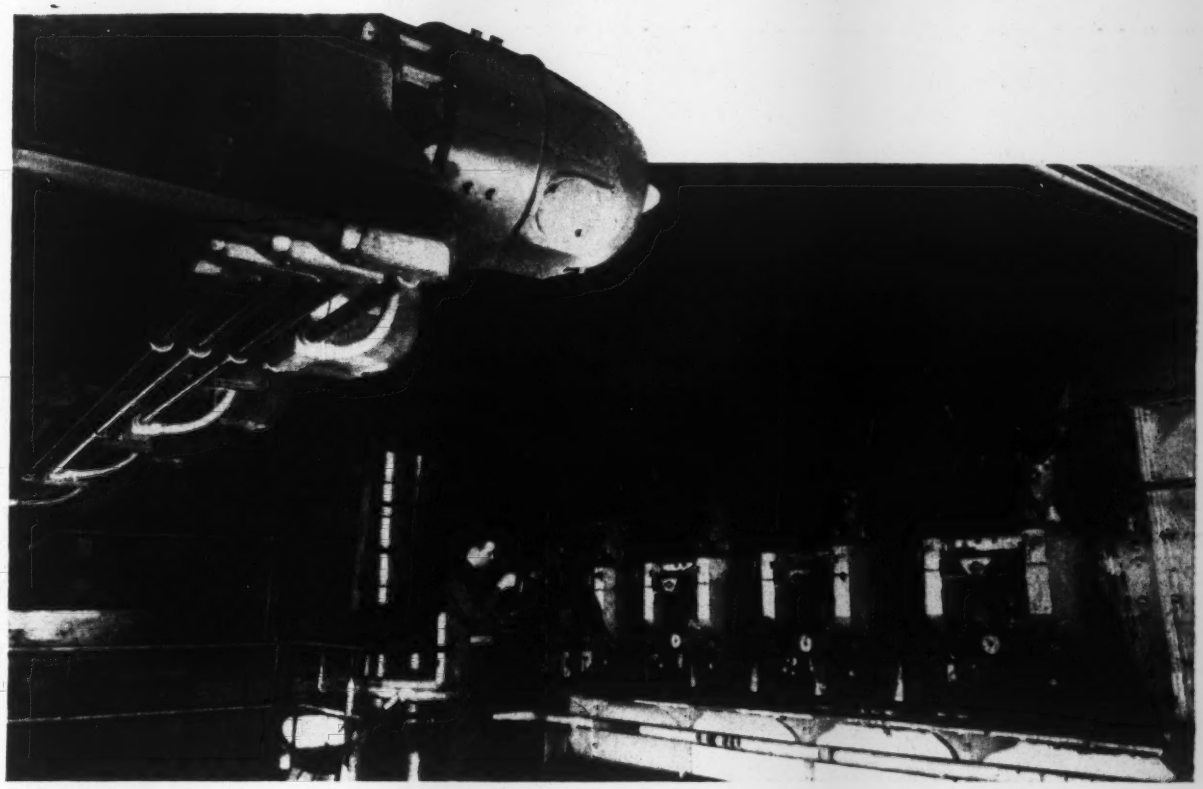
and Bigelow-Liptak Export Corporation

2550 W. GRAND BLVD. • DETROIT 8, MICHIGAN

UNIT-SUSPENDED WALLS AND ARCHES

In Canada: Bigelow-Liptak of Canada, Ltd., *Toronto, Ontario*

ATLANTA • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DENVER • HOUSTON • KANSAS CITY, MO. • LOS ANGELES • MINNEAPOLIS • NEW YORK PITTSBURGH • PORTLAND, ORE. • ST. LOUIS • ST. PAUL • SALT LAKE CITY • SAN FRANCISCO • SAULT STE. MARIE, MICH. • SEATTLE • TULSA • VANCOUVER, B.C.



Drive mounting problems erased with Westinghouse *Life-Line** Gearmotors

Putting the best drive in the minimum space is a problem constantly facing design engineers. In answer to this problem, Westinghouse Life-Line Gearmotors provide unit compactness, rugged construction and job-proved efficiency.

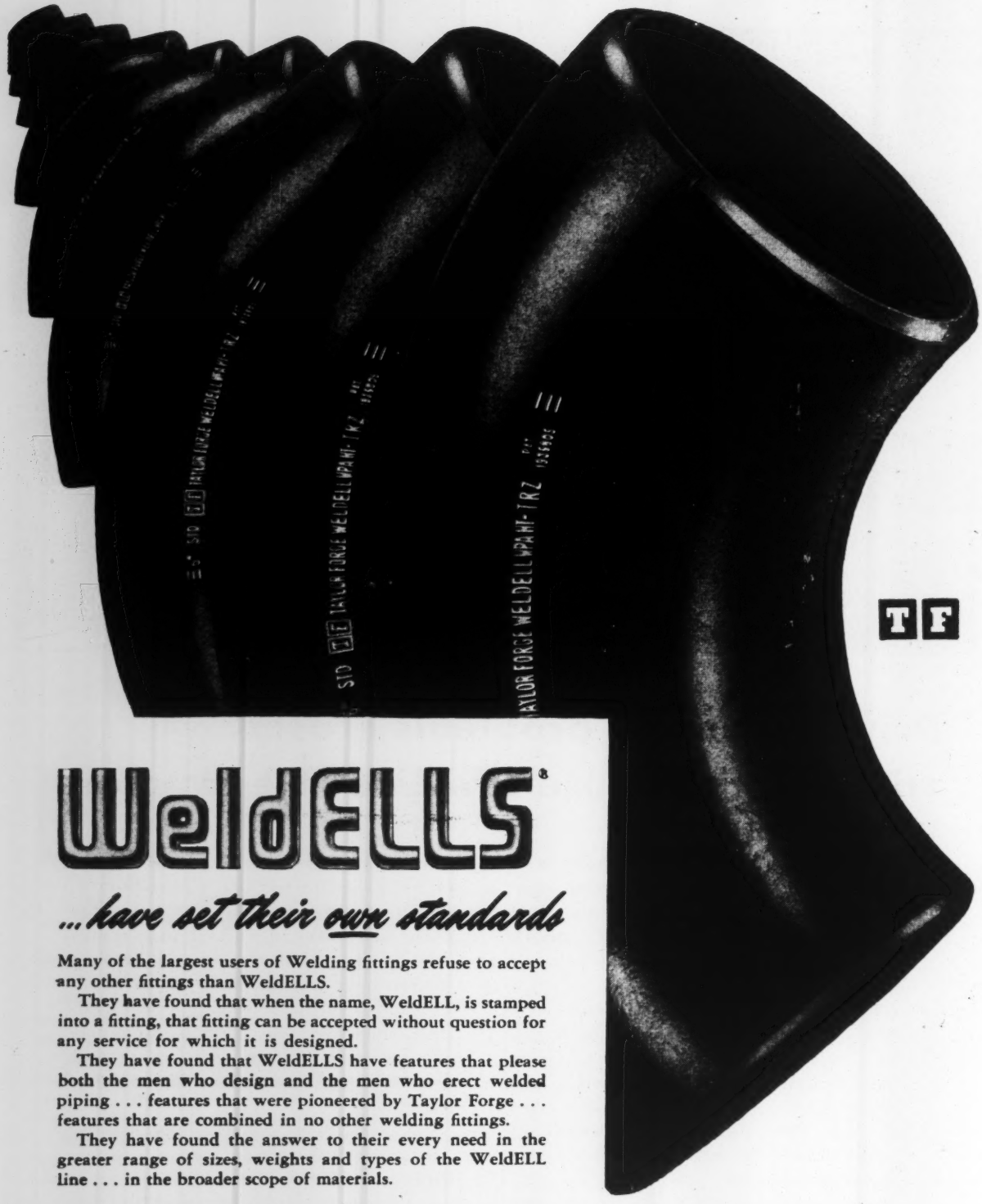
Westinghouse Life-Line Gearmotors have both motor and gears designed as an integral unit. As a result, there's a major saving in space because all belts, chains and pulleys can be eliminated. This means no alignment problems. Since integral design lessens the number of wearing parts, over-all maintenance is cut to a minimum.

With split-case gearmotors, there's no need to allow large work areas for removal or dismantling—all servicing can be done with the gearmotor "on the job". Split-case construction permits the gear cover to be removed in minutes and makes all working parts readily accessible. Any servicing, therefore, becomes a simple, speedy operation.

Taper-hardened gear teeth, thorough lubrication and industry-tested Life-Line Motors are but a few of the features which assure long, dependable performance from Westinghouse Gearmotors.

Your local Westinghouse Representative will gladly furnish you with additional information. Call him at any time or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. *Trade-Mark J-07322

YOU CAN BE SURE...IF IT'S
Westinghouse



WeldELLS®

...have set their own standards

Many of the largest users of Welding fittings refuse to accept any other fittings than WeldELLS.

They have found that when the name, WeldELL, is stamped into a fitting, that fitting can be accepted without question for any service for which it is designed.

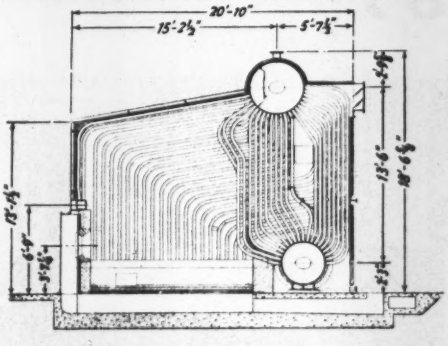
They have found that WeldELLS have features that please both the men who design and the men who erect welded piping . . . features that were pioneered by Taylor Forge . . . features that are combined in no other welding fittings.

They have found the answer to their every need in the greater range of sizes, weights and types of the WeldELL line . . . in the broader scope of materials.

TAYLOR FORGE

TAYLOR FORGE & PIPE WORKS, General Offices and Works: P.O. Box 485, Chicago 90, Ill.
Offices in all principal cities. Plants at: Carnegie, Pa.; Fontana, Calif.; Hamilton, Ont., Canada

Erie City VC's



BOILER DATA

Boilers (4)	Type 4 VC-28-30
Capacity each	33,000 lb/hr
Design Pressure	300 p.s.i.
T T Steam	366 F
Fuel	Oil

FOR FLEXIBLE OPERATION

These four identical VC units may suggest a similar solution to your steam modernization program. With furnace sides, front and top water cooled, these compact 2-drum water tube boilers concentrate maximum steam producing capacity in minimum cubage.

Multiple units permit operating at peak efficiency over a wide variation of loads. Investigate multiple units in your steam modernization program. Economize with a multiple installation of medium size . . . standardized units available for any method of firing.

Ask for BULLETIN VC-9

You can depend on Erie City for sound engineering

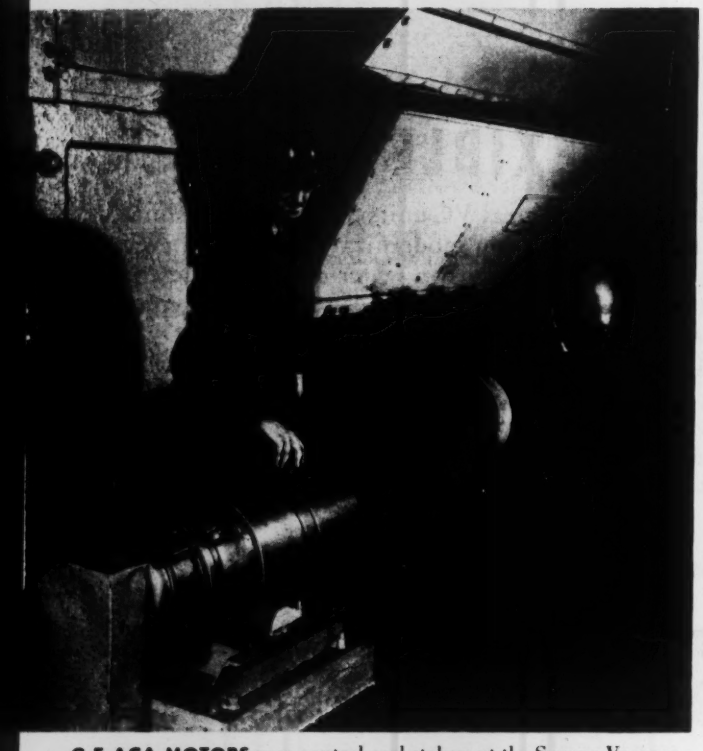
ERIE CITY
112 Years in Steam Generation

ERIE CITY IRON WORKS • *Erie, Pa.*

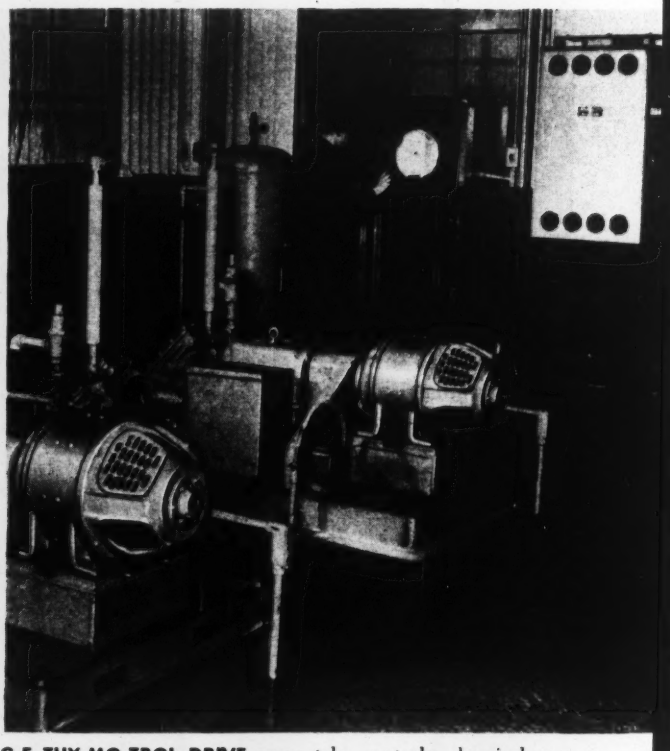
STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS
UNDERFEED AND SPREADER STOKERS • PULVERIZERS

CONTROL SENSITIVITY of the G-E Speed Variator at the Jefferson Mill Inc., Jefferson, Ga., helps cut costs by enabling the operator to speed up the splicing of the cloth rolls . . . enables him to easily control processing speed for any type of cloth. The Speed Variator is a packaged unit . . . easily installed in any convenient location . . . provides your machine with stepless speed control up to a 40 to 1 ratio.

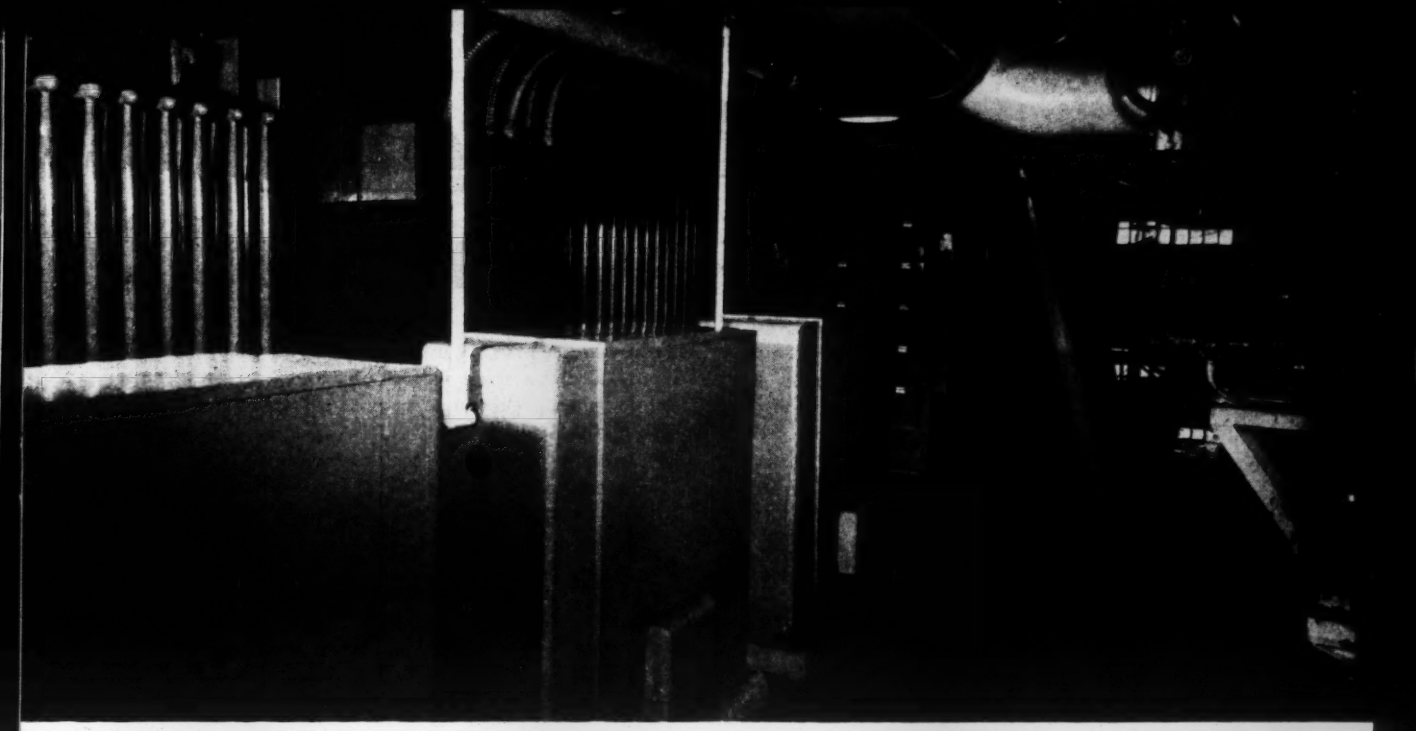
Cut Costs by modernizing your machines



G-E ACA MOTORS now control coal stokers at the Socony-Vacuum Oil Co., Inc., Olean, N. Y. Working directly from AC current the ACA motor offers low cost, low range stepless speed adjustment.



G-E THY-MO-TROL DRIVE accurately controls chemical proportioning pumps at Fibreboard Products, Inc. East Antioch, Calif. This electronic drive offers precise control in speed ranges up to 100 to 1.



G-E SPEED VARIATORS at the Ohio Boxboard Co., Rittman, Ohio, centralize control of various stock preparation processes . . . guard stock thickener speeds. Here you see three of the Speed Variator units—foreground . . . Available in ratings from 1 to 200 hp the versatile G-E Speed Variator can be adapted for even closer speed regulation by the addition of an amplidyne or electronic regulator.

with a G-E Adjustable-Speed Drive!

Here are four manufacturers who have effectively improved one or more of the manufacturing operations in their plants by modernizing their equipment with G-E Adjustable-Speed Drives.

In the same way the proper application of adjustable speed can minimize waste and increase production for you. In addition, adjustable speed by making your present equipment more flexible, will enable you to manufacture a greater variety of goods.

G-E Adjustable-Speed Drives give you economical speed regulation as close as 1% if necessary . . . assure you of correct stepless speed adjustment. Standard drives are available in ratings from 1/40 to 200 hp with speed ranges from 3 to 1 up to 100 to 1.

For full information consult your nearest General Electric Apparatus Sales Office. Your G-E Sales representative will be glad to recommend the most economical drive best suited to your operation. For printed information on the complete line of Adjustable-Speed Drives, use the coupon.

You can put your confidence in—

GENERAL ELECTRIC

LET G.E. HELP YOU PICK THE RIGHT DRIVE

Because only General Electric makes all major types of electric adjustable-speed drives, it is best qualified to help you select the right drive. Send for these informative bulletins.

☐ **A.** This 26-page manual describes all four types of drives and where to apply them. Bulletin GEA-5334.

☐ **B.** Lower cost, simplest a-c drive. Bulletin GEA-4883.

☐ **C.** More flexibility, moderate cost. Bulletin GEA-5335.

☐ **D.** Top performance, 1/40—30 hp. Bulletin GEA-5337.

☐ **E.** Top performance, 1–200 hp. Bulletin GEA-5336.

General Electric Company
Section E 546-24
Schenectady 5, N. Y.

Please send me the bulletins checked
☐ for reference only
☐ for planning an immediate project

NAME .....

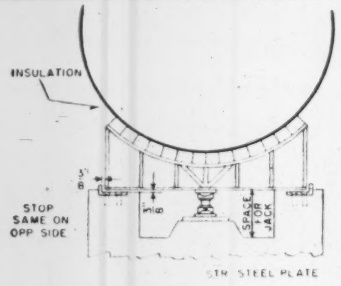
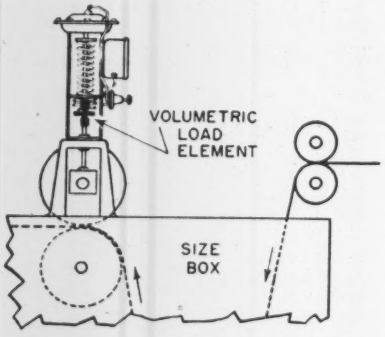
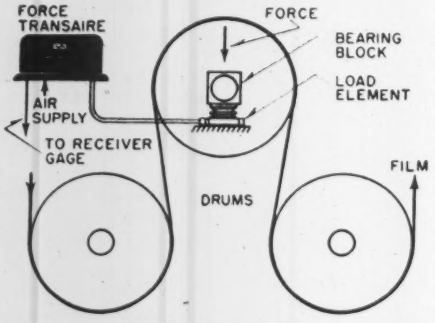
COMPANY .....

ADDRESS .....

CITY ..... STATE .....

Let us take a load off your mind!

DO YOU have a tricky load measurement problem on your mind? Something like measuring the tension on a conveyor belt for example, or the thrust on a bearing, or the weight of solids or corrosive liquids in a tank . . . ? Taylor volumetric load measuring elements have been used for years in paper mills, but there are many applications throughout the industry where these highly accurate and sensitive instruments are proving invaluable. Most recent developments afford a wide variety of ranges, greater range suppression, greater over-range protection and greater energy for positioning the pen or actuating a control mechanism. Applicable to tension and compression loads. Call your Taylor Field Engineer or write for **BULLETIN 98232.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

PROBLEM	SOLUTION	CHARACTERISTICS
To accurately measure the weight of chlorine in tanks		**Spool type Load Measurement Element** **Range limits:** 0-240,000 lbs. for compression loads, maximum load not to exceed 400,000 lbs. Applicable to horizontal or vertical tanks, containing corrosives or solids, making conventional level measuring devices impractical. Tension loads 0-30,000 lbs.
To accurately measure squeeze roll pressures on textile slashers		**Diaphragm type Load Measuring Element** **Range limits:** 0-5,000 lbs., maximum load not to exceed 6250 lbs. Compound ranges, tension—0—compression also available. Applicable to measure roll or nip pressures in calender stacks, press section and many other finishing operations involving processing of material between rolls.
To measure film tension within very close limits as a measure of "gain" or percentage of stretch		**Transaire Volumetric Load Measuring Element** **Range limits:** 0-300 lbs. in range spans as short as 30 lbs. Used in conjunction with a TANSAIRE* Pressure Transmitter which sends an output air pressure to an indicating, recording or controlling receiver proportional to the force applied. Applicable to film, paper, yarn or similar tension measuring requirements.

*Reg. U.S. Pat. Off.

TAYLOR INSTRUMENTS MEAN ACCURACY FIRST

PRESS BUILDER USES Trabon SYSTEMS FOR POSITIVE LUBRICATION

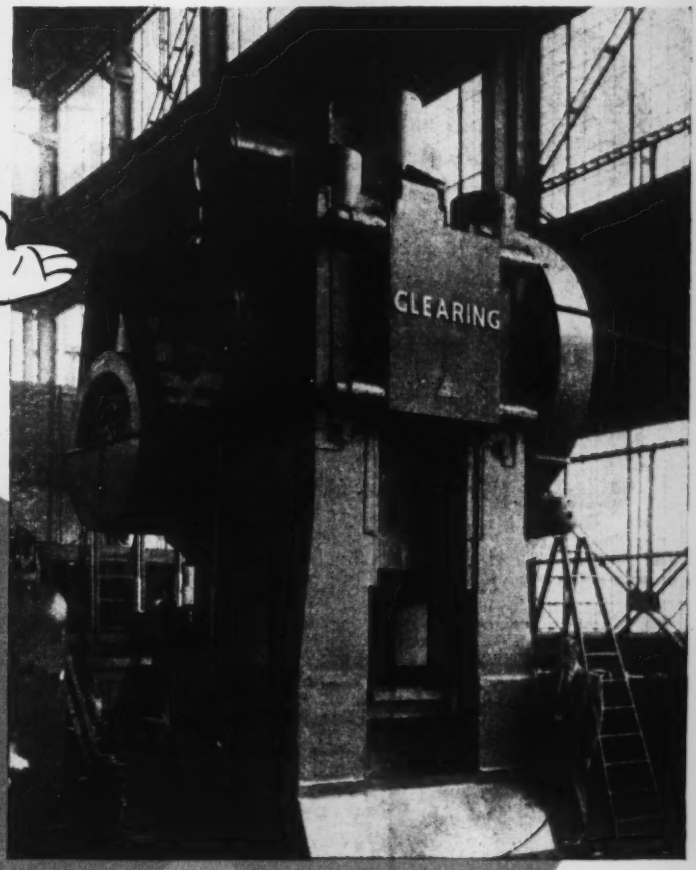


Photo courtesy Clearing Machine Corp., Chicago

this has a BEARING on the subject

TRABON *automatic* lubrication on this Clearing forging press lubricates 36 bearing points while the press operates under full load. This completely trouble-free system has eliminated bearing burnouts and costly shutdowns.

A TRABON system on *your* equipment will do the same job efficiently, economically and positively.

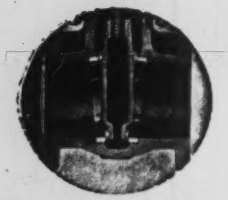
Remember, it's impossible to under-lubricate or skip a bearing with a TRABON positive system . . . a single indicator at the pump tells the operator when every bearing is properly lubricated.

Fully hydraulic . . . economical . . . for oil or grease . . . safe . . . completely sealed.

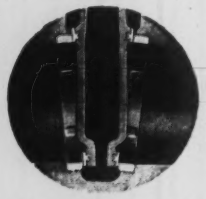
There are more Trabon Automatic Lubrication Systems in use than all other makes!

Write for Bulletin No. 529

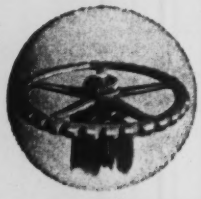
Trabon ENGINEERING CORPORATION
1814 E. 40th STREET • CLEVELAND 3, OHIO
Oil and Grease Systems



Straight-Flow Port Design reduces fluid turbulence to a practical minimum.



Seat Rings of end-seated type are screwed into the body.



Sure-Grip Malleable Handwheel for non-skid gripping even with heavy gloves.

WALWORTH

iron body gate valves

with screwed or flanged ends

... 8 Outstanding Features

Brass Liner on Glands assures greater resistance to corrosion and scoring.

For complete information on these new Walworth Iron Body Valves, see your local Walworth distributor, or write for bulletin 106.

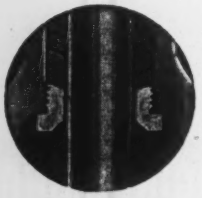
WALWORTH

valves and fittings

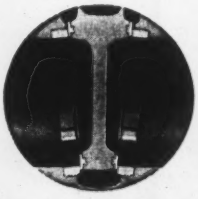
60 EAST 42nd STREET NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

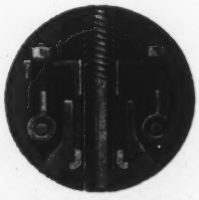
T-head Disc-to-Stem connection on OS&Y types provides stronger connection, prevents loosening of disc by corrosion.



Bronze Back-Seat Bushings in bonnets of OS&Y valves.



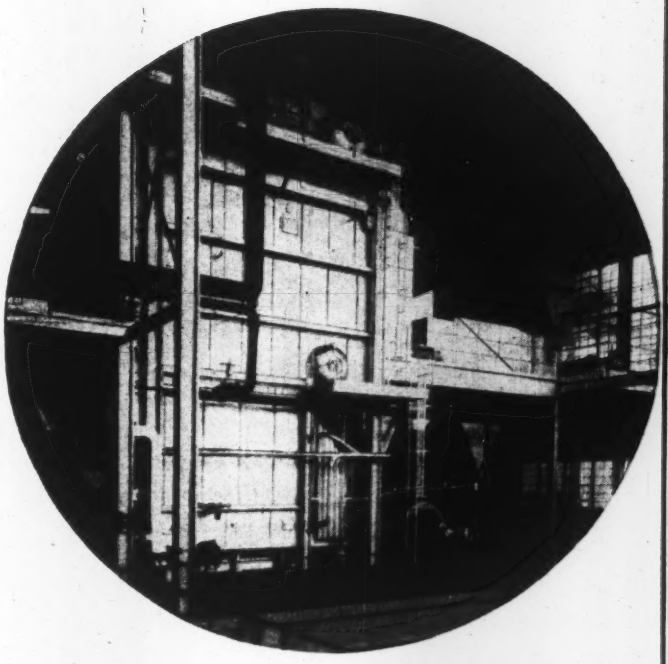
Solid Web Type Disc in OS&Y valves for greater strength and longer service.



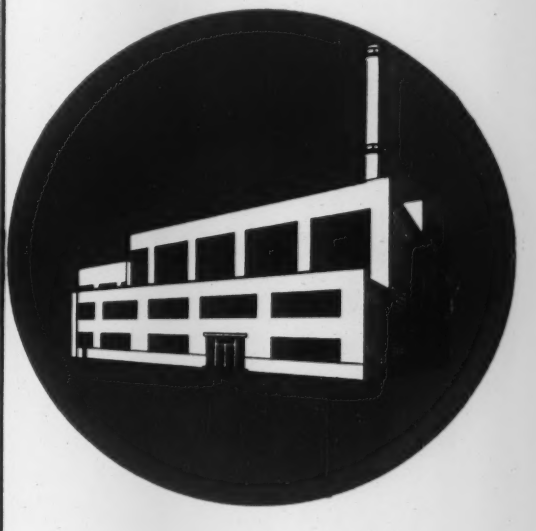
Hinged Gland Eye-Bolts on OS&Y valves permit faster, easier repacking under full pressure.

City of Manitowoc installs fifth WICKES steam generator

To provide a dependable source of power for the City of Manitowoc, Wisconsin, the Manitowoc Public Utilities Commission has just installed a fifth WICKES Steam Generator capable of producing 175,000 lbs. of steam per hour at 525 psi. Final steam temperature is 750°F. The new WICKES Boiler has 11,600 sq. ft. of heating surface. It is equipped with an economizer and fired by spreader stoker.



R. E. Cannard — Chief Engineer and General Manager



WICKES can fill your requirements for all types of multiple drum boilers generating up to 250,000 lbs. steam per hour at pressures up to 1000 psi. adaptable to any standard method of firing — oil, gas, single retort underfeed or spreader stoker. For pressures up to 900 psi. with sustained steam production up to 35,000 lbs. WICKES Type A Boilers can be shop assembled, ready for immediate installation. Write today for descriptive literature or consult your nearest WICKES representative.

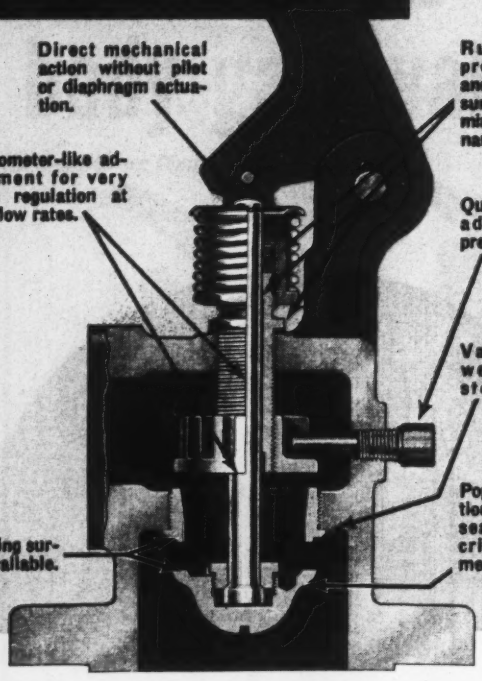
THE WICKES BOILER CO., SAGINAW, MICHIGAN RECOGNIZED QUALITY SINCE 1854
DIVISION OF THE WICKES CORPORATION

SALES OFFICES: Albuquerque, N. M. • Atlanta • Boston • Charlotte, N. C. • Chicago • Cincinnati • Cleveland • Dallas • Denver • Detroit • Fort Wayne, Ind. • Greensboro, N. C. • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New York City • Orangeburgh, S. C. • Pittsburgh • Portland, Ore. • Saginaw • Salt Lake City • San Francisco • Springfield, Ill. • Tampa, Fla. • Tulsa • Washington, D. C.

150

POPPET TYPE VALVES

An IMPORTANT REASON for the better performance of *these* DIAMOND Blowers

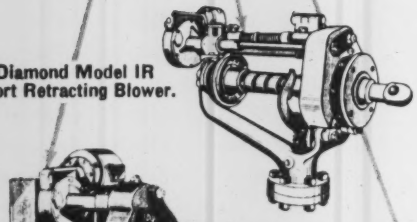

Direct mechanical action without pilot or diaphragm actuation.
Rugged stem, proper guiding and small packing surface result in minimum maintenance.
Micrometer-like adjustment for very close regulation at low flow rates.
Quick and simple adjustment of pressure control.
Valve seat is welded in on steel heads.
Poppet construction assures tight seating without critical adjustment.
Stellited seating surfaces are available.

Note carefully the important advantages pointed out on the illustration above. You will see why Diamond Poppet Type has proved its superiority by many years of successful operation on the most difficult jobs.

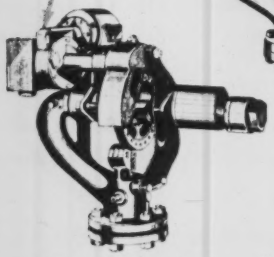
The integral adjustable pressure control device is used when boiler or header pressure is higher than desirable for blowing. Its location outside the path of valve travel permits full and immediate opening of the poppet valve, thus avoiding wire drawing.

The valve readily lends itself to examination and repair. Disc and seat are quickly accessible, and regrinding can be done quickly without dismounting the head. Seat and disc are forged and the stem rolled from stainless steel.

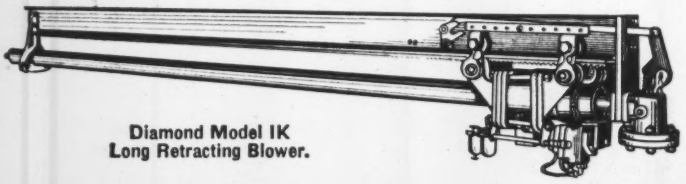
This valve construction is one of the many reasons why Diamond Blowers give better boiler cleaning at lower cost.



Diamond Model IR
Short Retracting Blower.



Diamond Model G9B
Automatic Valved Blower.



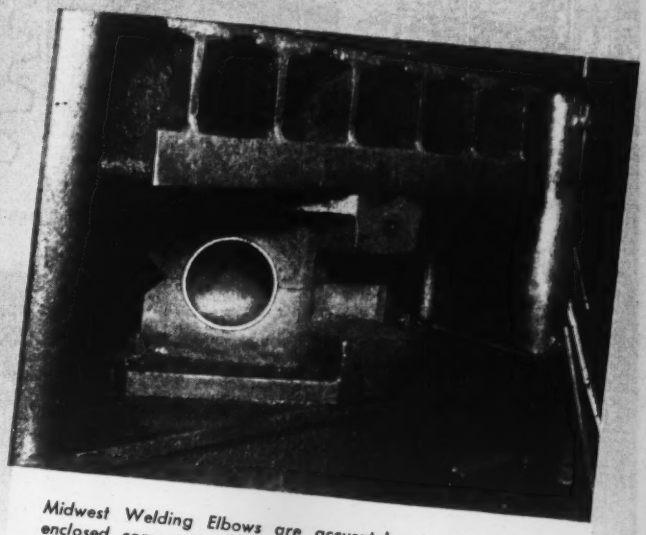
Diamond Model IK
Long Retracting Blower.

DIAMOND POWER SPECIALTY CORP.
LANCASTER, OHIO
Diamond Specialty Limited, Windsor, Ontario

6258

Held to CLOSE LIMITS

The child cooped in his playpen is held to close limits for his own safety and health. Midwest Welding Fittings are held to close limits to save you time and money on your welded piping. Because of their exceptional dimensional accuracy and uniformity (see below), all pipe can be cut in advance according to drawings with assurance of accurate fit. Welders do not have to spend costly time struggling to line up fittings and pipe. Welding proceeds rapidly and economically with no time-wasting compensation for inaccuracies. It will pay you to specify "Midwest" the next time you order welding fittings.



Midwest Welding Elbows are accurately sized in totally enclosed compression dies that exactly control metal distribution throughout fitting. The result is true circular cross section and accurate radius, included arc, and tangents.

Main Office: 1450 S. Second St., St. Louis 4, Mo.

Plants: St. Louis, Passaic, Los Angeles and Boston

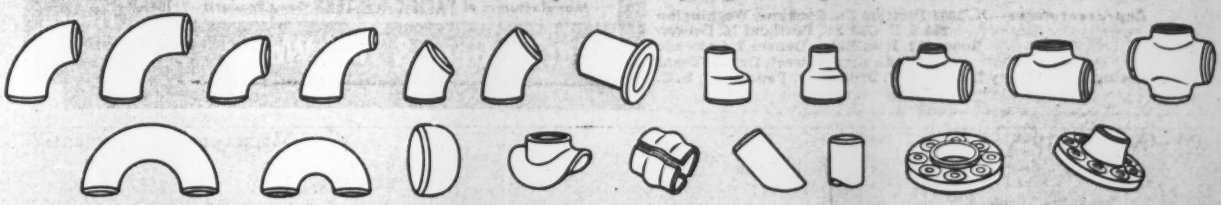
Sales Offices:

New York 7—50 Church St. • Chicago 3—79 West Monroe St.
Los Angeles 33—520 Anderson St. • Houston 2—1213 Capitol Ave.
Tulsa 3—224 Wright Bldg. • Boston 27—426 First St.

STOCKING DISTRIBUTORS IN PRINCIPAL CITIES

MIDWEST WELDING FITTINGS

MIDWEST WELDING FITTINGS Improve Piping Design and Reduce Costs



Since 1888 — 65 years of progress

WE OFFER

GEARS

and

GEAR PRODUCTS

for every requirement

SAN FRANCISCO SHOP

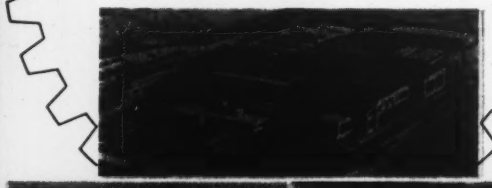
Offering the

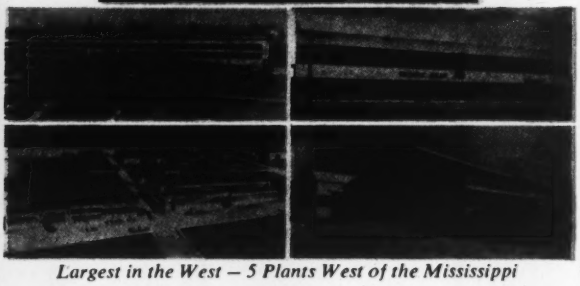
FINEST

in gear-making skill

WESTERN GEAR WORKS

provides a complete engineering service for every mechanical power transmission requirement.





Largest in the West — 5 Plants West of the Mississippi

• Speed Reducers • Agitator Drives • High Speed Units • Special Transmissions • Aircraft Actuators • Accessory Drives • Gears of all types and sizes • Special Machined Parts

Catalogs available — please write, wire or phone your nearest Pacific-Western Office.

5316

WESTERN GEAR WORKS

Manufacturers of PACIFIC-WESTERN Gear Products

Pacific Gear & Tool Works

Plants: Seattle
San Francisco
Belmont
(S. F. Peninsula)
Lynwood
(Los Angeles County)
Houston

Plants—417 Ninth Ave. S., Seattle 4, Washington
2600 E. Imperial Highway, Lynwood (Los Angeles County), California
1035 Folsom St., San Francisco 3, California
Belmont (San Francisco Peninsula), California
132-134 W. Colorado St., Pasadena 1, California
117 N. Palmer St., Houston 3, Texas

Representatives—N. 2605 Division St., Spokane, Washington
930 S. E. Oak St., Portland 14, Oregon
Room 212, Ross Bldg., Denver 2, Colorado
500 South Ervay Street, Dallas, Texas
Engineering & Machinery Ltd., 1366 W. Broadway, Vancouver, B. C.

Hundreds of thousands of installations prove . . .

FAST'S Couplings are FIRST!

There's no stronger endorsement of Fast's Couplings than the close to three-quarter million Couplings installed in the 33 years since their design revolutionized the power coupling business!

Trouble-free performance that saves down-time, maintenance, and money led to that record. And, whatever your coupling applications, it's a guarantee of what *you* can expect from Fast's! Fast's Couplings give you *rugged construction* . . . because their original design has been maintained without basic change or sacrifice in size or materials. Fast's Couplings give you *lowest cost per year* . . . because they usually outlast the equipment they connect. And Fast's Couplings give you the benefit of Koppers *free engineering service* . . . assuring you of the right coupling for any job and the right solutions to tough coupling problems.

Write today for full details to KOPPERS COMPANY INC., *Fast's Coupling Dept.*, 350 Scott St., Baltimore 3, Maryland.

KOPPERS®

THE ORIGINAL

FAST'S Couplings

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE, MD. This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Koppers-Elex Electrostatic Precipitators, Aeromaster Fans and Gas Apparatus.

Engineered* Products Sold with *Service

KOPPERS COMPANY, INC., *Fast's Coupling Dept.*, 350 Scott St., Baltimore 3, Md.

Gentlemen: Send me a Fast's Catalog giving detailed descriptions, engineering drawings, capacity tables and photographs.

Name .....

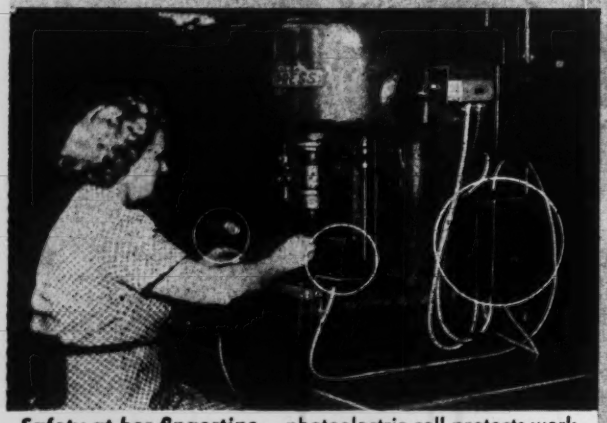
Company .....

Address .....

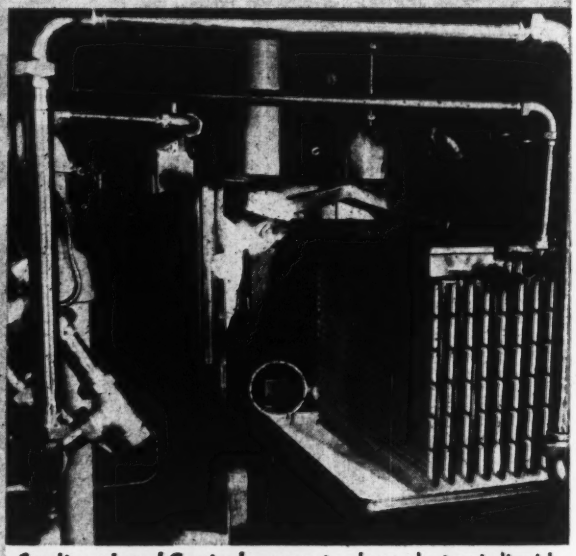
City ..... **Zone** ..... **State** .....

"Electron-eering" with photoswitch controls

Your next step in
control-efficiency

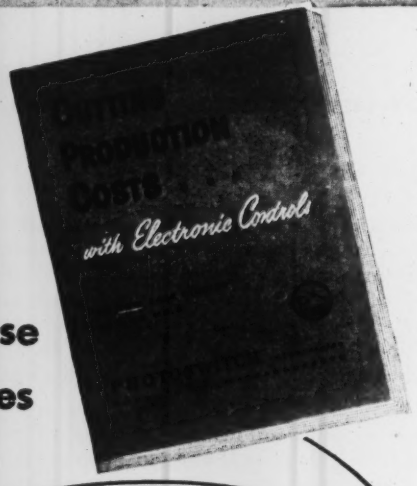


Safety at her fingertips — photoelectric cell protects worker's hand at this punch press. Press starts instantly when hand is withdrawn, increasing production, cutting costs.



Sanitary Level Control — easy-to-clean electronic liquid level control maintains precise level of fluid milk, regardless of foam, in cooler at modern dairy.

New!
46 Case Studies



This book can save you money!

Right off the press! Crammed with new factual data and explanatory diagrams, this booklet tears aside all hocus-pocus and gives you a clear understanding of how electronic controls can solve your industrial problems. You'll find valuable tested ideas — broadly applied to industries — on achieving efficiency through "Electron-eered" counting, weighing, measuring, timing and cycling. Completely indexed. It can save you real money!

Beer coming up! — and photoelectric cells count each case unerringly, however closely spaced. Other controls provide completely automatic centralized distribution between storage areas and loading platform.

Offices in all principal cities

Photoswitch, Incorporated

Dept. MA 10, 77 Broadway, Cambridge 42, Mass.

Send free, "Cutting Production Costs with Electronic Controls."

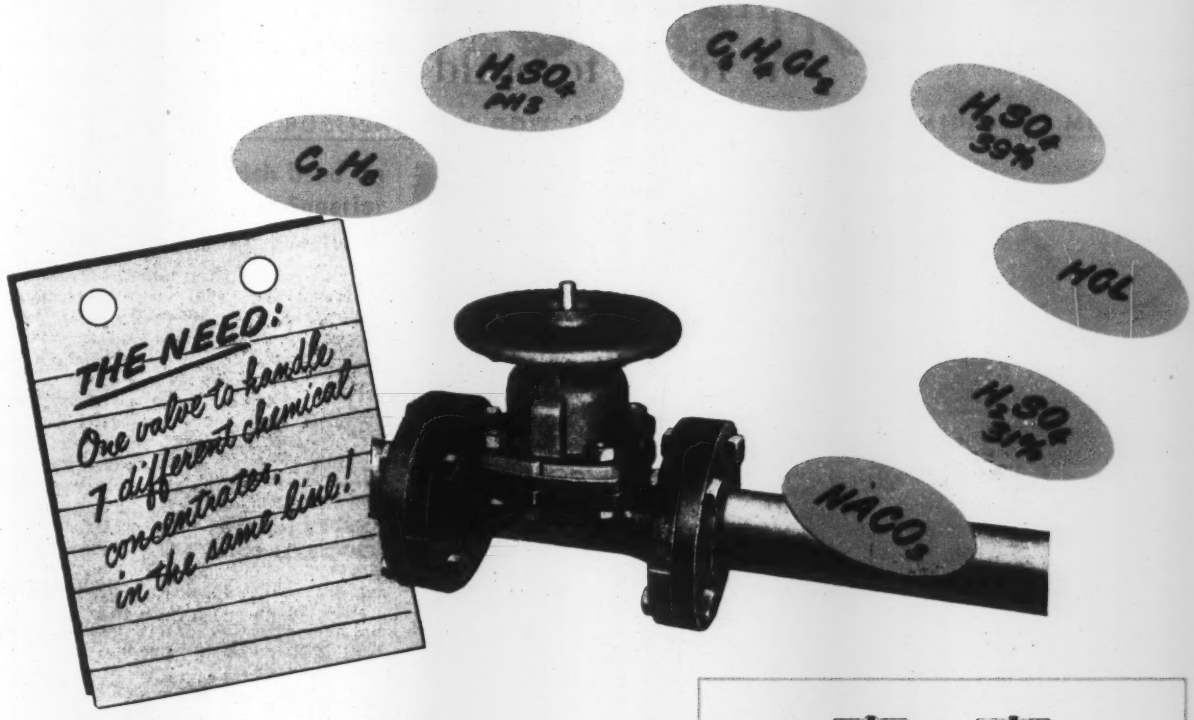
Name ..... Title .....

Company .....

Address .....

City ..... State .....

What valve would you specify?



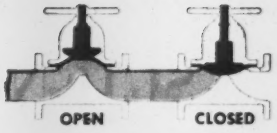
A manufacturer was looking for *one valve* which would handle *seven chemicals* of varying temperatures and concentrations, one after another, in the same line. They were . . .

SODIUM CARBONATE	PH 9	90°C
HYDROCHLORIC ACID	8%	100°C
SULPHURIC ACID	PH 3	20°C
SULPHURIC ACID	39%	42°C
SULPHURIC ACID	31%	15-20°C
TOLUENE	*(Full strength but associated with traces of other chemicals)*	

ORTHODICHLOROBENZENE — Cleaning Solvent

Valves suitable for use with these chemicals individually were available. But only *one valve* was found which could handle them in combination. It was the Grinnell-Saunders Diaphragm Valve, glass lined, with chemically inert KEL-F Diaphragm. The Grinnell KEL-F diaphragm not only prevented the liquid from attacking working parts, but it eliminated leakage around the stem.

Piping in today's complex industrial plants is an exacting science involving the handling of highly corrosive fluids, gases, compressed air, beverages, foods and suspended solids . . . in lines where corrosion, abrasion, contamination, clogging, leakage and maintenance are costly factors. Under such conditions, the amazing adaptability of the Grinnell-Saunders Diaphragm Valve explains its acceptance by industry after industry. For further details, write for Grinnell-Saunders Diaphragm Valve Catalog.



Features which have made Grinnell-Saunders Diaphragm Valves the specified valve in many different industries:

Streamlined flow. Smooth, streamlined passage, without pockets. Frictional resistance at a minimum.

Leak-tight closure against grit, scale, suspended solids.

Working parts absolutely isolated from fluid. Diaphragm completely seals off working parts from fluid in the line.

Body, lining and diaphragm materials to meet service condition. Bodies stocked in cast iron, malleable iron, stainless steel, bronze and aluminum; other materials on special orders. Valve bodies lined with lead, glass, natural rubber or neoprene. Diaphragm materials of natural rubber or synthetics.

Minimum maintenance. No refacing or reseating is required. No packing glands to demand attention. New diaphragm can be inserted without removing valve body from the line.

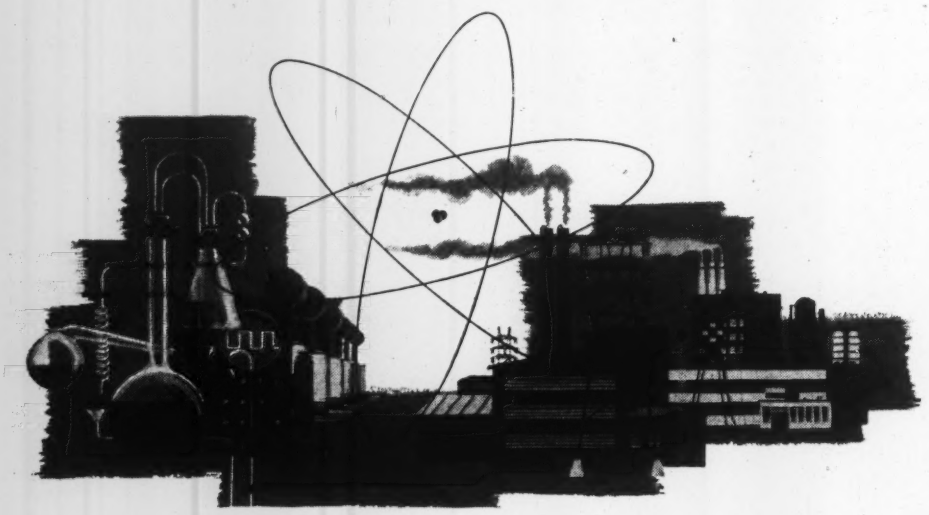
GRINNELL

WHENEVER PIPING IS INVOLVED

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

NORTH AMERICAN AVIATION
is ready to build



NUCLEAR REACTORS FOR SCIENCE AND INDUSTRY

North American Aviation is ready now to design and build nuclear reactors to fit the research and power production needs of any qualified educational, medical or industrial group.

As in the case of proposals now in process, North American will provide all engineering services necessary for reactor development and operation, offering the widest possible range of reactor application. North American is also prepared to supply accessory equipment . . . as well as a variety of services essential to the success of various atomic projects.

Through its work with the Atomic Energy Commission and other government agencies, North American has developed one of the most complete atomic research and production facilities to be found in private industry . . . staffed by one of the nation's largest groups of outstanding engineers and scientists.

North American invites your inquiry regarding reactor development or any other project in which atomic energy can be put to productive use. All reactor development is undertaken in accordance with the provisions of the Atomic Energy Act and subject to approval of the Atomic Energy Commission.

NORTH AMERICAN AVIATION, INC.

ATOMIC ENERGY RESEARCH DEPARTMENT • DOWNEY, CALIFORNIA

DOW CORNING

Silicone News

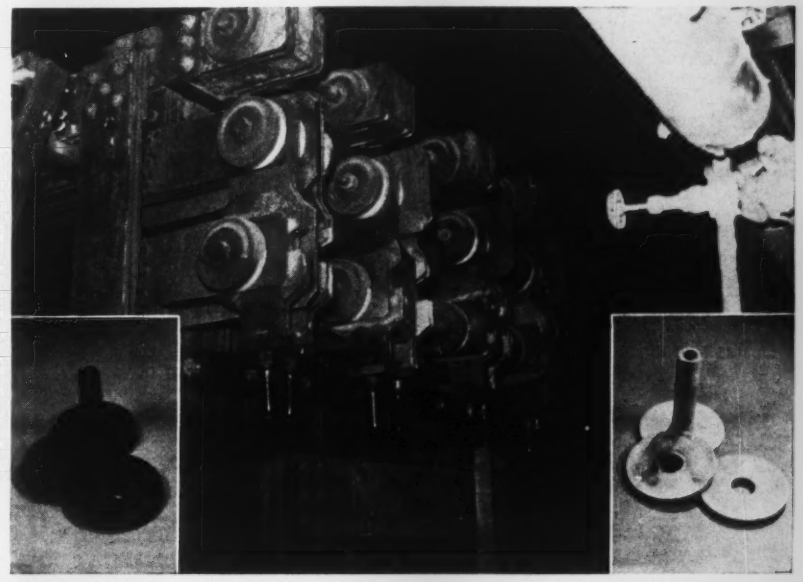
Vol. 1, Number 2 • PUBLISHED BY DOW CORNING CORPORATION, MIDLAND, MICHIGAN

Modified Silicone Finish Used On Vehicle Heaters For Its Superior Heat And Salt Spray Resistance

Heaters manufactured for use in Ordnance vehicles by the Southwind Division of Stewart-Warner Corporation must withstand temperatures far higher than those involved in civilian applications. In the process of selecting the best finish for these units, the relative heat and corrosion resistance of organic and modified silicone paints were severely tested. The photograph shows the results.

The heater shell at left was sprayed with a modified silicone paint which is formulated by Midland Industrial Finishes, and baked for 30 minutes at 400 F. A similar unit, at right, was sprayed with conventional olive drab (TT-E-485b), and baked for 45 minutes at 250 F. Panels in the foreground illustrate the appearance of both finishes before testing.

Both shells were held at 500 F for 4 hours. The conventional finish was then exposed to salt spray for 100 hours. The modified silicone finish was similarly exposed to a salt spray for 300 hours or three times as long. The organic finish was stained, faded, and badly disintegrated, while the silicone coating remained virtually unchanged. As a result, Stewart Warner specified the modified silicone finish for all such heaters. *No. 11*



Silicone Switch Spacers Serviceable After 30 Months; Organic Spacers Lasted Less Than 1 Month

Thirty days was the maximum service life obtainable with cotton-phenolic spacer disks and tubes used to insulate the knife switches on a 45,000 ampere graphitizing transformer.

The organic insulators shown in the left insert were removed after less than 30 days. Operating temperatures ranging from 400 to 500 F converted them to charred, cracked, shrunken conductors. Constant shrinkage required daily tightening of switches; kept maintenance costs up. Replacement meant loss of an entire day's production.

The silicone-glass spacer disks and tubes shown at right were examined during a routine shutdown after 11 months' service. They were in excellent condition and the switches had never required tightening. At that time the silicone-glass laminates had already repaid many times their original cost by increasing production, reducing maintenance costs and down time.

Again, after 30 months of service these silicone-glass laminates were inspected and found to be in very good condition. Insulation value was still high and switch tightening had been virtually eliminated.

Electrical insulating materials coated, impregnated or bonded with Dow Corning silicone varnishes and resins give electrical engineers unprecedented freedom in design; save copper; permit substantial reduction in size and weight of electric machines. They give maximum overload protection; provide maximum life and reliability in spite of overloads, high ambients and humid or corrosive atmospheres; substantially eliminate fire hazard caused by failure of conventional insulation. *(Continued pg. 2)*

Silastic* Die-Tips Give Long Service In Hot-Stamping Plastic Ornaments

Mass production of the multi-colored ornaments common to even the least expensive automobiles, is accomplished by hot-stamping pigmented foil to the molded plastic parts.

A problem in developing the process was to find a resilient die-tip material. Mass production techniques required that the material should not stick to the foil at surface temperatures in the range of 500 F, and remain resilient after thousands of impressions at such elevated temperatures. After trying many materials, the problem was solved with Silastic by the Bay Manufacturing Division, Electric Auto-Lite Co. The same Silastic tips have been in use for more than 3 years, and none of them has worn out, lost its flexibility or peeled from its metal backup plate.

The heat stability and aBhesiveness characteristic of Silastic have proved to be equally useful in other similar applications. Silastic-coated pressure plates, backing bars or press pads are used in printing or sealing plastic packaging materials. Silastic rings are used on banding machines to press gold leaf ribbon on cosmetic containers. Silastic-covered rolls are used in the hot or cold dip coating of fabrics, plastic film and metal sheeting or foil. *No. 12*

* T. M. REG. U. S. PAT. OFF.

DOW CORNING Silicone News

NEW DEVELOPMENT AND TECHNICAL DATA

For copies of any of the publications reviewed in this column or for data relating to any of the articles printed in this issue of the Dow Corning Silicone News, simply circle the corresponding reference number on the coupon below.

"Tall Tales and Fabulous Facts" is a new 24-page booklet in which a parallel is drawn between the tall tales our ancestors told about such legendary characters as Paul Bunyan, Davy Crockett and Pecos Bill and some of the equally fabulous facts about Dow Corning silicone products. *No. 15*

•

Use of bare magnet wire coated with new Dow Corning 1360 Wire Enamel permits operation of small electric machines and electronic parts at 180 C. Flexibility, scrape hardness and dielectric strength compare favorably with those of the best organic wire enamels. Life expectancy at 180 C is in the range of 50,000 hours compared with 200 hours for wire insulated with conventional enamels. *No. 16*

•

Pharmaceutical properties of Dow Corning 200 Fluids are described in a recent reprint from the Journal of American Pharmaceutical Association. This article includes a study of compatibilities with acids, alcohols, waxes and commercial ointment bases. *No. 17*

•

"Silicones Help Convair B-36 Fight Cold." This reprint of an article from Aviation Week describes and illustrates various nonrestricted applications for Silastic and other Dow Corning Silicones in one of the largest aircraft, operating at temperatures ranging from —100 to +500 F. *No. 18*

•

Current Aeronautical Material Specifications and SAE-ASTM Specifications for silicone rubber are outlined in a data sheet which also lists the Silastic stocks which meet these specifications. Handy reference for any design engineer working on military projects. *No. 19*

•

Now available, the new 1953-54 Reference Guide to Dow Corning Silicone Products summarizes properties and briefly describes applications for commercially available silicones. Indexed for easy reference. A "must" in every designer's catalog file. *No. 20*

•

New Antifoam A Spray bomb instantly defoams many of the most violent and persistant foamers. Spray consists of Dow Corning Antifoam A combined with Freon propellent and is effective in concentrations as low as 0.1 to 1 ppm. Now available from laboratory supply houses. *No. 21*

DOW CORNING CORPORATION - Dept. QI-10
Midland, Michigan

Please send me: 11 12 13 14 15 16 17 18 19 20 21

NAME _____

COMPANY _____

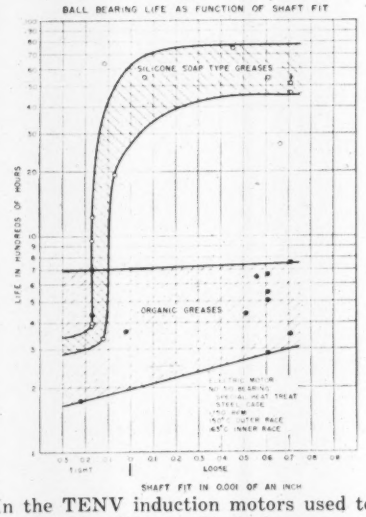
TITLE _____

CITY _____ ZONE ____ STATE _____

Bearings Fitted To Compensate For Thermal Expansion Further Extend Service Life of Silicone Grease

In electric motors which may operate hot, the mechanical fit-up of the bearing assembly has a critical effect on the life expectancy of silicone grease. This was proved by the life-testing of various greases in the bearings of totally enclosed nonventilated induction motors operating at high temperatures. The relation between shaft-fit and life in hours is shown in Figure 1.

FIGURE 1
BALL BEARING LIFE AS FUNCTION OF SHAFT FIT



In the TENV induction motors used to test bearing life at 150 C, these curves indicate that the life of Dow Corning 44 lubricated bearings with a shaft-fit of 0.2 mils loose is about 15 times the life of identical bearings with a shaft-fit of 0.2 mils tight.

These data show the importance of mechanical fit-up. A tight shaft-fit, for example, may take up most of the radial clearance in the bearing. Where the inner race operates at a higher temperature than the outer race, unequal thermal expansion may put the balls under compression. Any combination of mechanical fits which produces radial clearances inadequate at operating temperatures, or poor bearing alignment, will subject the grease to extreme pressures and result in unsatisfactory bearing life.

The test data also showed that an end play of at least nine thousandths of an inch[1] was effective in extending the service life of silicone grease lubricated bearings.

The subject of Design Considerations for Optimum Performance of Silicone Greases in Ball Bearings is more fully developed in a paper read before the ASLE. *No. 14*

KNIFE SWITCH SPACERS *continued*

These advantages were inherent in the first silicone resins and varnishes introduced over ten years ago by Dow Corning Corporation. Since that time many improvements have been made and new silicone dielectrics are constantly being introduced by our research chemists and product engineers.

For example, Dow Corning 2105 is a relatively new silicone product for making silicone-glass laminates that retain a dielectric strength of 180 volts per mil after 5000 hours at 250 C. That's approximately 100 times the dielectric life of the best laminates previously available. This new resin exhibits slight thermoplasticity at elevated temperatures, but not enough to limit its use in most applications where maintenance of dielectric strength is of importance.

The following table compares typical physical properties of silicone-glass laminates made from ESS 261, washed glass cloth, bonded with Dow Corning 2103 Resin and Dow Corning 2105 Resin. Operating conditions will determine which type of laminate is most suitable for specific applications. *No. 13*

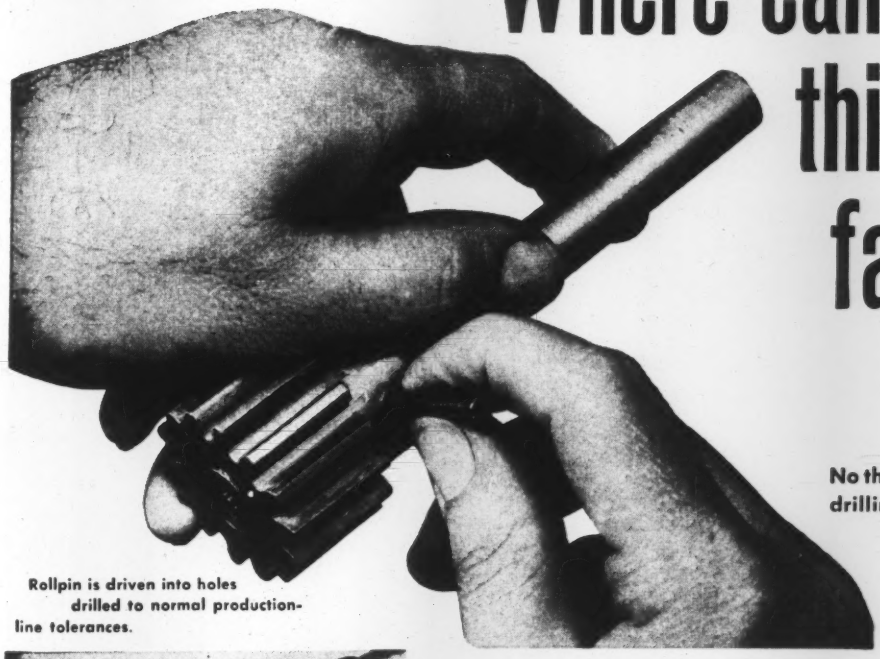
Typical Properties	Laminates of ESS 261 Washed Cloth Bonded with 2103 Resin	2105 Resin
Thickness	⅛"	⅛"
Flexural Strength, psi		
at 77 F	26,500	24,500
at 500 F	10,100	4,200
at 500 F, after aging 100 hr at 500 F	6,400	2,500
Bond Strength, pounds	1,050	1,000
Water Absorption[1], percent	0.150	0.05
Dielectric Strength, volts per mil ¼" electrodes	85	250
Dielectric Constant[2] at 25 C		
at 10^2 cycles		3.62
at 10^6 cycles	3.88	3.40
Power Factor[2] at 25 C		
at 10^2 cycles		0.0250
at 10^6 cycles	0.0120	0.0036
Arc Resistance	250	280

[1] After 24 hour immersion.
[2] Samples conditioned 24 hr at 25 C prior to testing.

DOW CORNING CORPORATION
First in Silicones
Atlanta
Chicago
Cleveland
Dallas
Detroit
MIDLAND, MICHIGAN
Los Angeles
New York
Washington, D. C.
(SILVER SPRING, MD.)
In Canada: Fiberglas Canada Ltd., Toronto
In England: Midland Silicones Ltd., London

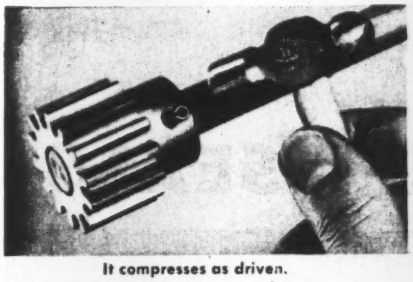
Manufacturers of
Silicone Fluids
Silicone Abhesives
Silicone Adhesives
Silicone Release Agents
Silicone Compounds
Silicone Greases
Silicone Water Repellents
Silicone Bonding Resins
Silicone Electrical Insulating Resins
Silicone Molding Compounds
Silicone Expansible Resins
Silicone Defoamers
Silastic

Where can you use this simple fastener?

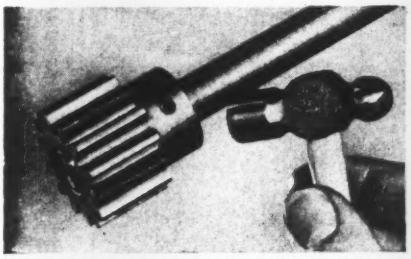


Rollpin is driven into holes drilled to normal production-line tolerances.

No threading, peening or precision drilling with ROLLPIN



It compresses as driven.



Rollpin fits flush . . . is vibration-proof.

Rollpin is the slotted tubular steel pin with chamfered ends that is cutting production and maintenance costs in every class of industry.

This modern fastener drives easily into standard holes, compressing as driven. Its spring action locks it in place—regardless of impact loading, stress reversals or severe vibration. Rollpin is readily removable and can be re-used in the same hole.

* * *

If you use locating dowels, hinge pins, rivets, set screws—or straight, knurled, tapered or cotter type pins—Rollpin can cut your costs. Mail our coupon for design information.

Elastic Stop Nut Corporation of America
Dept. R16-1011, 2330 Vauxhall Road, Union, N. J.

Please send me the following free fastening information:

☐ Rollpin bulletin

☐ Elastic Stop Nut bulletin

☐ Here is a drawing of our product. What fastener would you suggest?

Name _____ Title _____

Firm _____

Street _____

City _____ Zone ____ State _____

no chance for gas or liquid leaks

with SYLPHON SHAFT SEALS!

You can count on a Sylphon Seal to "leak-proof" a rotating shaft—seal it against seepage of gases or liquids. And do the job as you want it done. For Sylphon Seals are designed and engineered on order, exactly to *your* specific requirements.

Pictured here are typical examples of Sylphon Seals. They can be made to withstand pressures up to hundreds of pounds. They reduce friction—save power—minimize shaft wear.

Uses are many—hydraulic transmissions, refrigeration or air compressors, speed reducers, pumps, washing machines and other units. Size range is wide. Write for helpful engineering service. Ask for Catalog TK-825.

Examining surface of Sylphon Seals by means of optical flats, to make sure surfaces are flat and smooth.

FIRST WITH BELLOWS

Temperature Controls • Bellows Devices • Bellows Assemblies

FULTON SYLPHON
DIVISION

ROBERTSHAW-FULTON CONTROLS CO., KNOXVILLE 4, TENN.

They're Harnessing Cyclones....

with **REPUBLIC** *Automatic* **COMBUSTION CONTROL**

● At a major chemical plant, the first 100% cyclone-fired industrial power plant in the country is being controlled for maximum combustion efficiency by Republic combustion controls. The plant produces 800,000 lbs. of steam per hr. at 1250 psi and 830° F. Steam is supplied to both chemical processes and to a 30,000 kw double-extraction turbine generator.

This cyclone-fired plant serves as *additional proof* that Republic combustion control systems can be adapted for *any* type of fuel firing

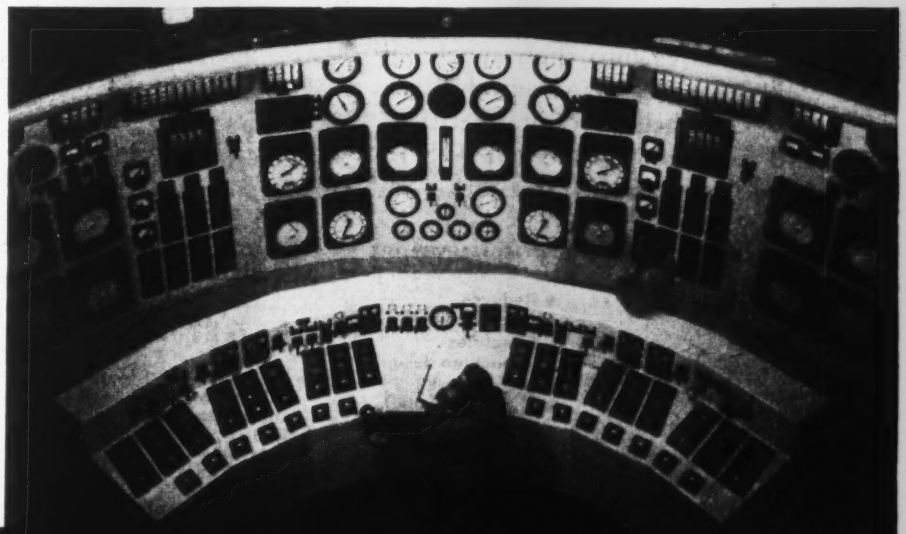
There are Republic combustion control systems for all sizes and types of boilers, all arrangements of draft equipment and for all load conditions. There's an experienced engineering staff* to help you get the combustion control system that best fits *your* needs.

For full information, write for Data Book S-21 or contact your nearby Republic field engineer.

**For more than 37 years, Republic has specialized in the design and manufacture of combustion control systems for all sizes of power generating stations.*

FOUR CYCLONES AT HIS FINGER-TIPS . . .

Two 400,000 lbs./hr. boilers fired by four cyclone furnaces are checked and controlled from this central control point. Republic sub-panels on the control bench board are provided for transferring between automatic and manual operation. Also included are Republic biasing sub-panels for adjusting coal-air ratio, primary-secondary air, cyclone ratio and boiler rating.



REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

STEP AHEAD...KEEP AHEAD

with the RELIANCE V★S DRIVE Jr. 3/4 to 3 HP

STYLE E

The All-Electric Adjustable-Speed Drive that eliminates mechanical gearboxes, clutches and variable-pitch cone pulleys

Reliance V★S Jr. is bringing the benefits of smooth, shockless operation... powerful starting... wide speed ranges... fast reversing... quick stopping...to users of small machinery in many industries. Progressive machinery builders, too, are building these desirable sales features into their machines with the V★S Jr. To step ahead... and keep ahead...of competition, find out today what the V★S Jr. can do on *your* application! D-1465

SAVES YOU MONEY 10 WAYS:

- Boosts output
- Cuts down rejects
- Saves space
- Increases safety
- Handles more jobs
- Reduces "down time"
- Simplifies machine design
- Reduces operator fatigue
- Cuts changeover time
- Operates from a-c.

GET THE FACTS!

Ask for Bulletin D-2102. It describes and illustrates features, applications, components and operation; dimensions and characteristics also are included.

RELIANCE ELECTRIC AND ENGINEERING CO.

1062 Ivanhoe Road, Cleveland 10, Ohio • Sales Representatives in Principal Cities

with pardonable pride, we consider ourselves

Tube Specialists

Come to Wolverine for ALUMINUM TUBE as well as Copper Tube

When you buy Wolverine aluminum tube you will do so with the same confidence that you have in buying Wolverine copper tube. That's because our aluminum tube is produced under the same top quality control that has brought distinction to our copper tube through our 36 years of tube manufacturing.

This tube lends itself most admirably for use in making television antennas and many types of indoor and outdoor furniture. It is also applicable in the refrigeration industry for suction lines.

This tube is made from 2S and 3S aluminum in standard sizes from ¼" thru 2" O.D., in wall thickness ranging from .020 thru .180. We are well equipped to meet your particular specifications.

In addition to plain aluminum tube, Wolverine also manufactures aluminum finned tube either in all aluminum or in bi-metal. It is known as Wolverine Trufin* and is especially suited for effective heat transfer. In bi-metal—Trufin combines the advantages of all-aluminum integrally finned tube with a liner of copper or a copper base alloy on the inside. (Of course, Trufin is also available in all-copper, copper base alloy, 1010 welded steel, and type 304 stainless steel.)

Trufin is available in 5 fins, 7 fins, 9 fins, 11 fins, 16 fins, and 19 fins per inch, with outside fin diameters ranging from ½" to 2".

Call your nearest Wolverine Sales Representative now to help you select the proper aluminum tube to meet your needs.

*REG. U.S. PAT. OFF.

Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ontario.

WOLVERINE TUBE DIVISION
of CALUMET & HECLA, INC.
Manufacturers of Quality-Controlled Tubing
1437 CENTRAL AVENUE • DETROIT 9 MICHIGAN

ESTABLISHED 1916

Plants in Detroit, Mich. & Decatur, Ala. *Sales offices in Principal Cities*

A new and exceptionally useful reference

GLOSSARY OF TERMS IN NUCLEAR SCIENCE AND TECHNOLOGY

Contains the authorized definitions of 2000 terms used in the fields of

REACTOR THEORY	CHEMICAL ENGINEERING	CHEMISTRY
REACTOR ENGINEERING	BIOPHYSICS AND RADIOBIOLOGY	METALLURGY
ISOTOPES SEPARATION	INSTRUMENTATION	PHYSICS

It is a nine-section glossary with each section listing and defining the terms (1) peculiar to its field, (2) used therein in a different sense or with different emphasis from what is most commonly understood in other connections, (3) used elsewhere in the same way but so infrequently as to be unfamiliar.

It includes an alphabetical listing of the terms of all sections which enable users to determine readily the section or sections in which the definitions of the term will be found.

It is reliable

Before publication, all entries were circularized for criticism and revised in the light of comments received.

It has the endorsement

of seventeen scientific and technical societies, ten national government agencies, and four divisions of the National Research Council.

It is easy to use

Each term is printed in bold face type and each difinition is clearly and concisely presented.

It is the reference

for all engineers and scientists in the nuclear energy field, and will be found especially valuable to those who are only slightly acquainted with the terms used outside their own field.

SPIRAL BINDING **$7.00**

20% Discount to ASME Members.

The sections of the Glossary are also obtainable separately at the following prices:

I Physics	$2.50	VI Biophysics and Radiobiology	$. 60
II Reactor Theory	1.50	VII Instrumentation	1.00
III Reactor Engineering	.75	VIII Isotopes Separation	1.20
IV Chemistry	.60	IX Metallurgy	
V Chemical Engineering	.60		

The American Society of Mechanical Engineers, 29 W. 39 St., New York 18

Why is Demineralization being selected instead of Evaporators?

When should we use three or four-bed rather than two-bed Demineralizers? Mixed Bed?

Should we include a Decarbonator?

How do you figure Demineralizer operating costs?

Which Ion Exchange material should we specify?

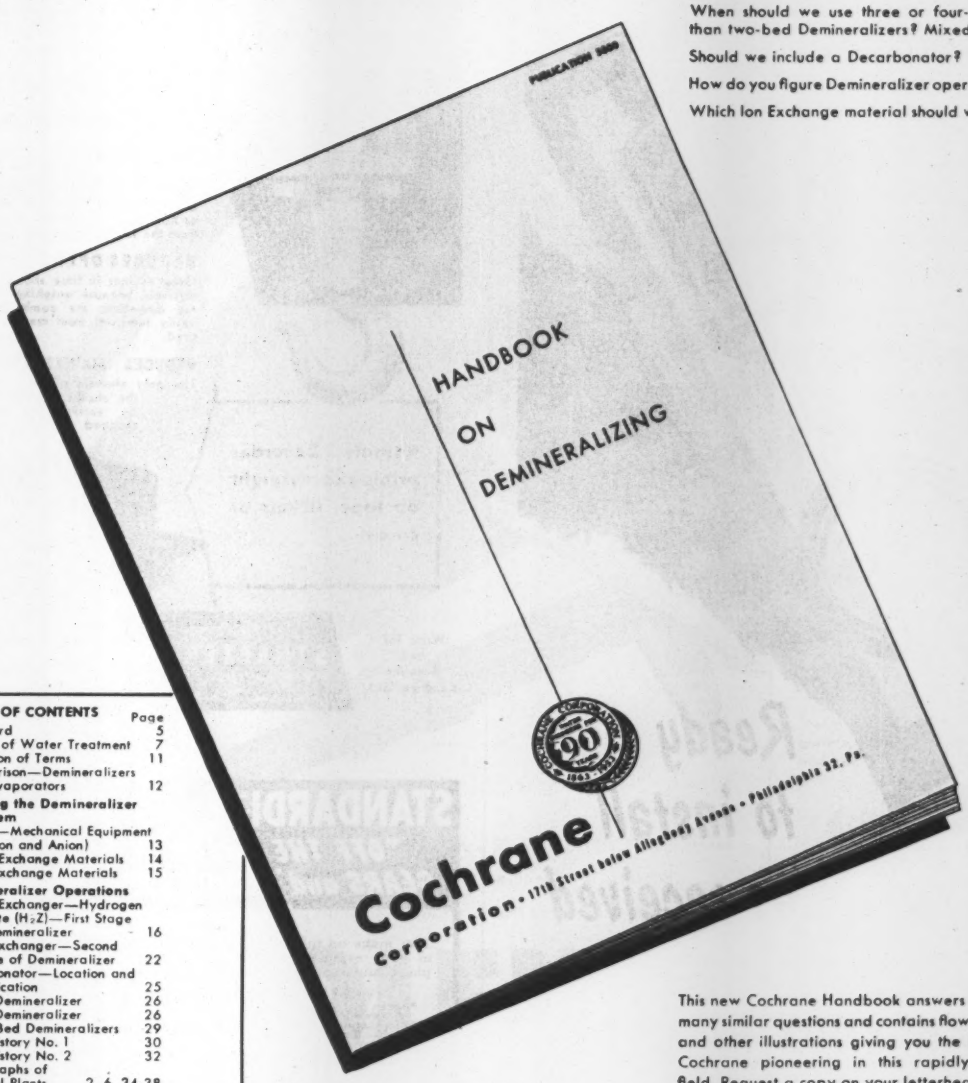


TABLE OF CONTENTS

	Page
Foreword	5
History of Water Treatment	7
Definition of Terms	11
Comparison—Demineralizers vs. Evaporators	12
Building the Demineralizer System	
Details—Mechanical Equipment (Cation and Anion)	13
Cation Exchange Materials	14
Anion Exchange Materials	15
Demineralizer Operations	
Cation Exchanger—Hydrogen Zeolite (H_2Z)—First Stage of Demineralizer	16
Anion Exchanger—Second Stage of Demineralizer	22
Decarbonator—Location and Application	25
3-Bed Demineralizer	26
4-Bed Demineralizer	26
Mixed Bed Demineralizers	29
Case History No. 1	30
Case History No. 2	32
Photographs of Actual Plants	2, 6, 34-38

This new Cochrane Handbook answers these and many similar questions and contains flow diagrams and other illustrations giving you the benefit of Cochrane pioneering in this rapidly growing field. Request a copy on your letterhead.

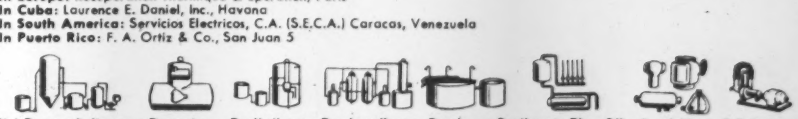
COCHRANE CORPORATION WATER ENGINEERS FOR 90 YEARS 1863 - 1953

cochrane

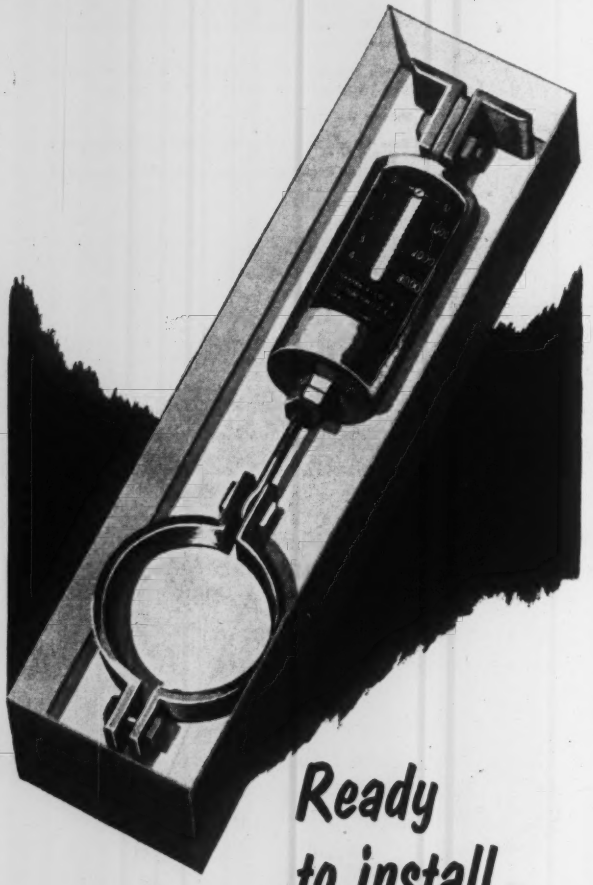
corp. *3142 N. 17th Street, Philadelphia 32, Pa.*

offices in 30 principal cities

In Canada: Canadian General Electric Co., Ltd., Toronto
In Mexico: Babcock & Wilcox de Mexico, S.A., Mexico City
In Europe: Recuperation Thermique & Epuration, Paris
In Cuba: Laurence E. Daniel, Inc., Havana
In South America: Servicios Electricos, C.A. (S.E.C.A.) Caracas, Venezuela
In Puerto Rico: F. A. Ortiz & Co., San Juan 5



Hot Process Softeners • Deaerators • Dealkalizers • Demineralizers • Reactors • Continuous Blow-Off • Specialties • C-B Systems



Ready to install as received

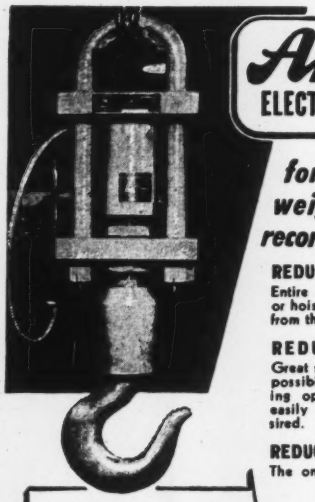
For any piping installation in which flexibility is important

BLAW-KNOX HANGERS

with patented Internal Swivel Action are "made-to-order." Each is a complete packaged unit . . . saving you expensive cutting, threading and assembling in the field. Other supports developed by Blaw-Knox Power Piping engineers include Overhead Roller Assemblies, Rigid Hanger Assemblies and Vibration Eliminators for any piping requirement. If you want data that will speed your specifications and cut your engineering time send for Catalog #51.

BLAW-KNOX COMPANY
POWER PIPING AND SPRINKLER DIVISION
PITTSBURGH 35, PA. • CEdar 1-0700

BLAW-KNOX



Ametron ELECTRONIC CRANE SCALE

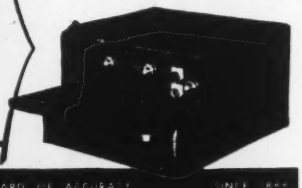
for heavy industrial weighing and remote recording

REDUCES INSTALLATION COSTS!
Entire assembly ready to attach to crane or hoist. Only a cable connection is run from the Load Cell to remote recorder.

REDUCES OPERATING COSTS!
Great savings in time and man power are possible because weighing and transporting operations are combined. Scale is easily removed from crane whenever desired.

REDUCES MAINTENANCE COSTS!
The only element subjected to weight is the sturdy load cell, which can be easily replaced or interchanged.

Remote Recorder prints exact weight on tape, tickets or cards!



Write for free Ametron Brochure G-2

THE STANDARD OF ACCURACY SINCE 1887
STREETER-AMET COMPANY
4101 N. RAVENSWOOD AVENUE • CHICAGO 13, ILLINOIS

STANDARDIZE WITH "OFF THE SHELF GEARS and REDUCERS"

OHIO STOCK DISTRIBUTORS

You make no mistake when you include an Ohio Gear Distributor in your engineering. You will find he fits into your production plans, and can save you time and money, too! Call him!

DISTRIBUTORS AND REPRESENTATIVES

*Akron 11, Ohio
Hardware & Supply Co.
*Baltimore 2, Md.
L. A. Benson Co., Inc
*Brooklyn 6, N. Y.
(Gears) Northside Leather Belting Co.
*Buffalo, N.Y.
*S. H. Pooley Belting Co.
F. E. Allen Co.
*Chicago, Ill.
Apex Power Equipment Co.
Schraide-Batterson Co.
*Cincinnati 14, Ohio
Metzger Machine Co.
*Cleveland, Ohio
J. A. Shomer Co.
Ohio Gear Co.
*Detroit 3, Mich.
Abrasive and Supply Co.
*Erie, Penn.
Cohen Industrial Supply
*Findlay, Ohio
Bearing & Transmission Co.
*Grand Rapids 2, Mich.
F. Ranlville Co.
*Hagerstown, Md.
Hagerstown Equip. Co., Inc.
*Hoboken, New Jersey
(Gears) Crown Industrial Sup.
Houston 3, Texas
Behring's Bearing Service, Inc.
*Indianapolis 2, Indiana
A. R. Young Company, Inc.
*N. Kansas City 16, Missouri
Sesco Engr. & Supply Corp.
*Los Angeles 1, Calif.
J.W. Minder Chain & Gear Co.
Louisville 2, Ky.
Alfred Halliday
*Massillon, Ohio
Hardware & Supply Co.
*Memphis 2, Tenn.
Memphis Bearing & Supply Co.
Milwaukee 11, Wisc.
A. F. Korf Co.
*Minneapolis 4, Minn.
Industrial Supply Co., Inc.
*Muskegon, Mich.
Lakeshore Machinery & Supply Co.
New Haven, Conn.
George G. Pragst
*New Orleans, La.
*(Gears) R. J. Tricon Co., Inc.
*(Reducers) Woodward Wight & Co., Ltd.
*New York, N. Y.
*(Reducers) Patron Trans. Co., Inc.
*(Gears) Atlantic Transmission & Gear Sales, Inc.
*Paterson 4, N. J.
(Gears) Bernstein Bros., Inc.
*Philadelphia, Pa.
*Robert L. Latimer Co.
*Rothman Belting & Equip. Co.
*Piqua, Ohio
Bormell Supply Co.
*Pittsburgh 30, Pa.
Standard Machinists Supply Co.
*Portland 14, Oregon
J.W. Minder Chain & Gear Co.
*Rochester 14, N.Y.
H. M. Cross & Son
*San Francisco 3, Calif.
Adam Hill Company
*St. Louis 4, Missouri
The Essmueller Co.
*Syracuse, N. Y.
U. S. S. Inc.
*Toledo 12, Ohio
G. & J. Bearings & Supply Co.
IN CANADA, *Montreal, Quebec,
John Braidwood & Sons, Ltd.
*Stocks Carried.

ESTABLISHED 1915
THE OHIO GEAR COMPANY
1360 EAST 179th STREET • CLEVELAND 10, OHIO

OHIO GEARS

Stopping rust with Rust-Oleum 769 Damp-Proof Red Primer
. . . for double protection use Rust-Oleum finish coatings
available in many colors, aluminum and white

RUST-OLEUM®

STOPS RUST!

Just scrape and wirebrush to remove rust scale and loose particles . . . then brush Rust-Oleum 769 Damp-Proof Red Primer *directly over the sound rusted surface*. Chemical pre-cleaning and other costly preparations are *not* usually required. Rust-Oleum finish coats in many colors provide *double protection*. Specify Rust-Oleum . . . prompt delivery from Industrial Distributor stocks in principal cities.

Applied by brush, dip, or spray.

RUST-OLEUM CORPORATION
2901 Oakton Street, Evanston, Illinois

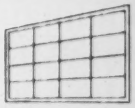
FREE SURVEY: Ask a Rust-Oleum specialist to conduct a survey including actual applications, tests, and recommendations. No cost or obligation.
See Sweets for nearest Rust-Oleum distributor or write for literature today.

. . . proved throughout industry for over 25 years

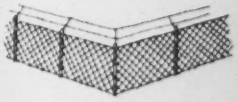
Such fields as Petroleum, Marine, Railroad, Mining, Agricultural, Steel, General Industry are but a few who rely upon Rust-Oleum. General weathering, heat, chemicals, salt water atmosphere, fumes, etc., are only a few of the conditions resisted by Rust-Oleum.

Water tanks, gas tanks, fuel tanks—Rust-Oleum protects your investment.

One truck, or a fleet of trucks, applied over rust, Rust-Oleum keeps them looking better . . . in service longer.

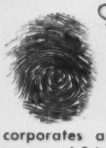


Metal sash and steel windows, roofs, gutters, fire escapes, railings—indoors and out need Rust-Oleum to stop rust.



Wire fence maintenance? Rust-Oleum's Extra-Long Nap Lamb's Wool Roller cuts re-coating costs up to 50% in some cases.

There is Only One Rust-Oleum

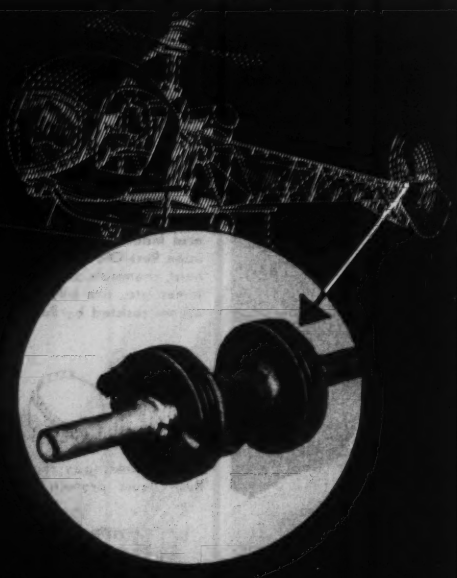


Rust-Oleum is an *exclusive formula* developed by a Master Mariner during more than 20 years battling actual rust conditions at sea. It incorporates a *specially-processed* fish oil vehicle that will *dry*, is *odor-free*, and is formulated in *many colors*. Be sure you specify genuine Rust-Oleum. Accept no substitute.

ATTACH TO YOUR LETTERHEAD-MAIL TODAY!

RUST-OLEUM CORPORATION
2901 Oakton St., Evanston, Illinois

- ☐ Have a Qualified Representative Call
- ☐ Free Survey
- ☐ Complete Literature
- ☐ Nearest Source of Supply



easier assembly... economical maintenance... with Linear "O" Rings

Linear O Rings perform an unusual job in Bell Aircraft helicopters. The bearing in the tail rotor drive was supported in a metal housing which, because of the metal-to-metal fit, was extremely difficult to install and remove.

By using Linear O rings for mounting the housing, replacement is made easier, maintenance simpler and less costly and a neater, more satisfactory installation is provided.

In many other parts of the helicopter, Linear O Rings provide tight fitting, space saving seals.

Whenever you need a fool-proof seal, why not consult the Linear Engineering Staff. Write or call Linear today for full information.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., State Rd. & Levick St., Philadelphia 35, Pa.

ALWAYS IN HIGH GEAR

For the production of precision built gears to meet your specifications. Diefendorf meets the demands of industry for gears of all sizes, metal and non-metallic, for specially designed equipment or for contract manufacture.

DIEFENDORF GEAR CORPORATION
920 West Belden Ave.
Syracuse 1, New York

DIEFENDORF GEARS

Engineers

AN INVITATION TO YOU TO GO PLACES WITH FAIRCHILD

Earl E. Morton, Chief of Aerodynamics. Has had many years of experience in aircraft manufacturing and was responsible for engineering on many now famous aircraft.

A secure future, exceptional opportunities for advancement, and a high starting salary await you at FAIRCHILD. We have openings right now for qualified engineers and designers in all phases of aircraft manufacturing.

Paid vacations, liberal health and life insurance coverage, 5-day, 40-hour week as a base. Premium is paid when longer work week is scheduled.

ENGINE AND AIRPLANE CORPORATION
FAIRCHILD *Aircraft Division*
HAGERSTOWN, MARYLAND

FARVAL SPRAY VALVES save 95% of lubricant and do 100% better job

FARVAL—*Studies in Centralized Lubrication* No. 149

COUNT the number of open gears on your machines. Multiply the amount of grease required for these gears by 95% and you'll have the savings in lubricant alone which Farval Spray Valves can bring.

Even more important than lubricant saving, the Farval Spray Valve spreads and maintains a uniform thin film of oil or grease evenly over all bearing areas —eliminates friction, increases efficiency, lowers power costs, reduces wear.

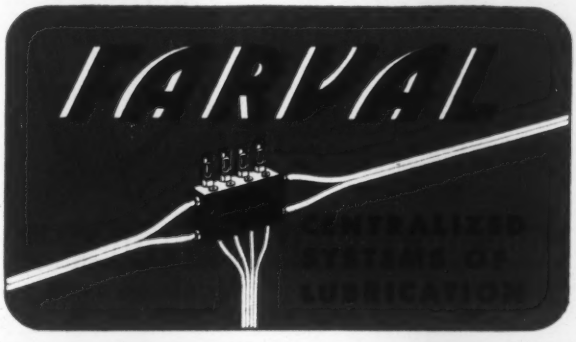
The Farval Spray Valve System is designed especially for lubricating open gearing and slide surfaces. Using an adaptation of the familiar Dualine Valve, this system sprays oil or grease from nozzles in just the right amount and at any desired interval.

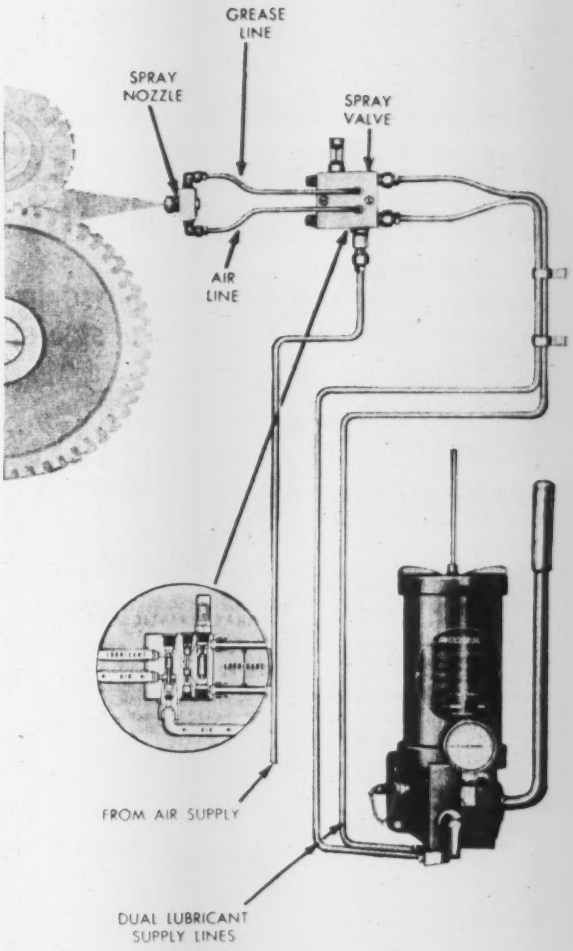
No more wasteful hand paddling of lubricant on gear teeth with the hope it will spread itself uniformly. No more blobs of grease splotching up the floor—creating safety hazards. The Farval Spray Valve System has proved it can maintain a clean, even film of lubricant at all times while machines are in operation. No waste. No mess. No trouble.

Farval Spray Valves can be inserted in a regular Farval Dualine System wherever compressed air is available. Or a complete Farval Spray Valve System may be installed, consisting only of Spray Valves served by a manual or automatic pumping unit. As indicated in the sketch at right, compressed air is directed through the Spray Valve, which meters air to the delivery nozzle at the same time that the lubricant is metered. Positive cut-off after delivery eliminates bleeding.

Why not insure that your open gearing and slide surfaces get the lubrication they need? Write for a copy of Farval Spray Valve Bulletin No. 60 today. The Farval Corporation, 3264 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.



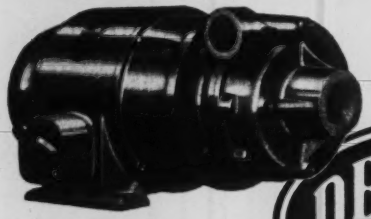


Drawing shows component parts of the Farval Spray Valve Centralized System of Lubrication—manual pumping station, dual lubricant lines, compressed air line, single Spray Valve and nozzle. Both automatic and manual systems installed three years ago are in operation today, prolonging gear life, saving labor and lubricant.

PERFORMANCE *IS GREAT—* MAINTENANCE *IS EASY...*

WHEN YOUR PUMP IS A PEERLESS *Fluidyne*

WIDEST RANGE OF SIZES, CAPACITIES AND HEADS—



¼ to 150 HP
10 to 5500 GPM

PEERLESS PUMPS

Choose Your Pump
FROM THE FLUIDYNE LINE

It's one of the broadest and most complete lines of horizontal end-suction general purpose pumps offered by any manufacturer. Two types are available, fitting most all piping and pumping layouts, as well as system sub-assemblies. Peerless Type PE is a close-coupled electric drive, using standard pump motors. Type PB is adaptable to flexible-coupled or belt-drive. Both types provide excellent efficiencies. They are compact, dependable, economical and durable. Maintenance is easy because Peerless design and construction are so simple. Apply them whenever you need an economical general purpose water handling pump.

CHARACTERISTICS AT A GLANCE

CAPACITIES AND HEADS

TYPE PE Close-coupled—¼ to 40 hp
Up to 65 gpm fractional hp sizes
Up to 1000 gpm integral hp sizes
Up to 110 ft. fractional hp sizes
Up to 200 ft. integral hp sizes

TYPE PB Flexible-coupled—¼ to 150 hp
Up to 50 gpm fractional hp sizes
Up to 5500 gpm integral hp sizes
Up to 90 ft. fractional hp sizes
Up to 260 ft. integral hp sizes

NEW BULLETIN *describes all the features of pumps in the Peerless Fluidyne line. Write for your copy of this profusely illustrated and detailed engineering bulletin today.*

MAIL COUPON TODAY

fmc PEERLESS PUMPS

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION
Los Angeles 31, California

Please send me a copy of Peerless Fluidyne Pump Bulletin No. B-2300.

NAME_____
COMPANY_____
STREET_____
CITY_____ STATE_____
ME

PEERLESS BUILDS DEPENDABLE PUMPS

Protect Your Machinery with...

—*maintenance-free* LOVEJOY FLEXIBLE COUPLINGS

When you install Lovejoy Flexible Couplings you get more than just long-lasting smooth power transmission. You get maximum protection against surge, backlash and starting torque. You get reduced down-time and less maintenance, since cushions can be changed without shutdown and Lovejoy Flexible Couplings *never* require lubrication.

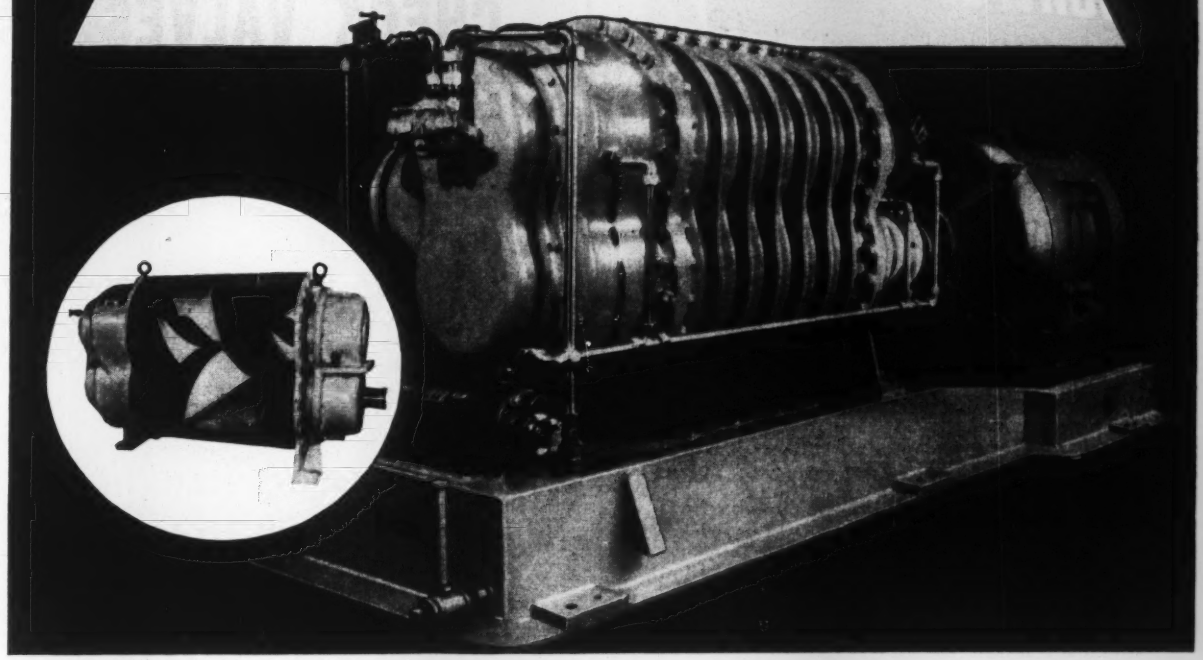
Accurately machined bodies and jaws and cushioning materials engineered to the load conditions are combined in a compactly designed coupling to keep your machinery running better . . . longer.

TYPES AND SIZES FOR ALL APPLICATIONS

Send for complete catalog . . . contains full technical data and handy selector charts for your convenience. Yours without obligation.

LOVEJOY FLEXIBLE COUPLING CO.
5032 West Lake St. Chicago 44, Ill.
Also Mfrs. of Lovejoy Variable Speed Pulleys and Universal Joints

NEW in principle ... design ... efficiency



ROOTS-CONNERSVILLE SPIRAXIAL COMPRESSORS

To its widely accepted *dual-ability* line of Rotary Positive and Centrifugal equipment for handling gas and air, Roots-Connersville announces the new SPIRAXIAL Compressors. Based upon the long-proved rotary blower, originally conceived by the Roots Brothers in 1854, but entirely new in operating principles, the SPIRAXIAL design offers several outstanding advantages over present types of compressors, within its range of use:

1. Peak efficiencies at discharge pressure determined by requirements.
2. No internal lubrication used or needed.
3. Minimum of servicing, with wearing parts quickly accessible.
4. Low noise level—smooth operation.
5. Light weight.

In operation, two "spirotors" revolve in opposite directions, and cause internal compression of the air or gas. This principle of internal compression leads to higher efficiencies, which begin to be pronounced at about 10 psi and are more pronounced at higher pressures, with internal compression performance up to at least a 3 to 1 ratio.

These new SPIRAXIAL Compressors increase the flexibility of the Roots-Connersville line and offer possibilities for economy and efficiency which are well worth investigating. We shall gladly study your requirements and make definite recommendations. Descriptive bulletin No. SC-152 on request.

ROOTS-CONNERSVILLE

Exclusive Specialists in Handling Gas and Air

BLOWER BUILDERS SINCE 1854

ROOTS-CONNERSVILLE BLOWER

A DIVISION OF DRESSER INDUSTRIES, INC.
1053 Michigan Ave. • Connersville, Ind.

Quick-As-Wink
AIR AND HYDRAULIC
Control Valves

FEATURE THIS MONTH

Single Plunger Solenoid Pilot Operated Valves

They'll give you millions of cycles of efficient trouble-free operation

● Quick-As-Wink Solenoid Valves are unsurpassed for positive, trouble-free dependable service . . . they give users millions of cycles of fast, high speed — and safe — operation. All parts are rugged. Low amperage requirement of the solenoid eliminates intermediate relays and simplifies electrical circuits. ⅜" to 2" sizes. 2-way, 3-way or 4-way actions. Bucking cylinder or double solenoid return. Send for the data sheets. Get full details about Quick-As-Wink, America's outstanding valve line, today.

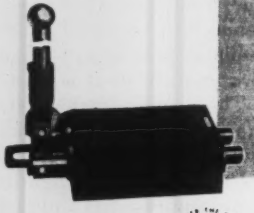
also the following

PUSH BUTTON OPERATED AIR VALVES

Push-pull or push and spring return operation — ⅛" and ¼" tapped connections. Widely used for controlling cylinders and many other applications. Air to 125 psi — vacuum—can also be used in low pressure hydraulic service.

LEVER OPERATED HYDRAULIC VALVES

Two position or three position valves ½" to 1½" sizes for line pressures 1000 to 5000 psi. Can be furnished in neutral, compound-exhaust or compound-on actions. Pilot cylinder operated types available up to 4".

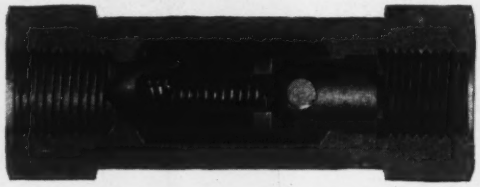


For Fully Descriptive Data Sheets Write

C. B. HUNT & SON, Inc.

Hand, Foot, Lever, Cam, Pilot, Diaphragm and Solenoid Control Valves

1952 EAST PERSHING STREET • SALEM, OHIO



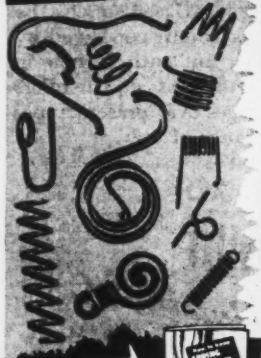
CHECK VALVES

- **ONE PIECE CONSTRUCTION**
  No welds or brazes to crack or fail—
  Available in ⅜", ½", ¾", 1" NPT lines sizes
- **NYLON POPPET**
  Assures leak proof trouble-free service
- **LIGHT WEIGHT**
  Aluminum body and nylon poppet reduce overall weight and increase ease of handling during installation
- **LOW PRESSURE DROP**
  Minimum pressure loss thru valve at rated flow

Write for illustrated circular G

WATERMAN ENGINEERING Company
725 CUSTER AVENUE
EVANSTON ILLINOIS

FOR Quality Performance from
WIRE FORMS
SPRINGS
METAL STAMPINGS



Rely on

DUDEK & BOCK

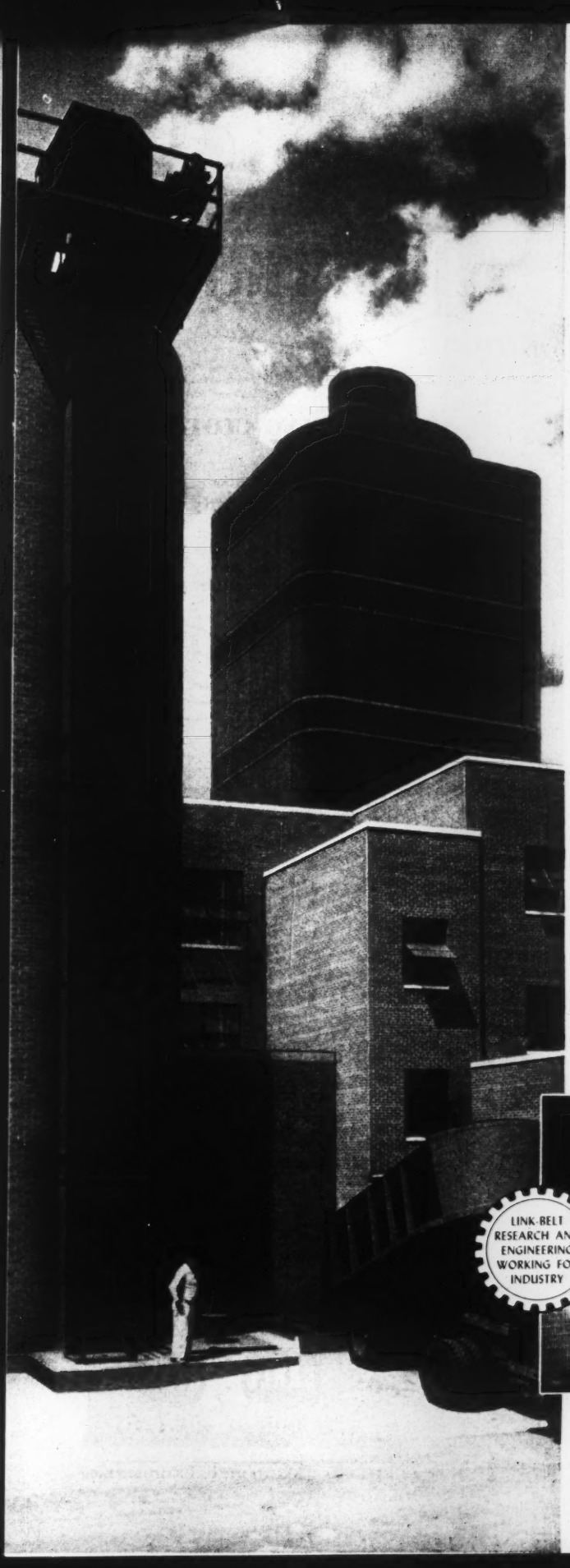
You get precision WIRE FORMS, Springs and Stampings that are easily assembled . . . that withstand stresses . . . perform under the most *trying* conditions. Rely on our free designing service. Our EXPERT ENGINEERS will produce designs that meet your *exact* needs—and save you MONEY!

Valuable FREE Brochure

SPEEDY DELIVERY
WRITE—WIRE or PHONE
for Estimates and Delivery Dates

Phone:
HAymarket 1-1880

DUDEK & BOCK SPRING MFG. CO.
2100 W. Fulton, Chicago 12, Illinois



Express elevator for coal in a hurry!

Bucket elevators are just one of many Link-Belt products that help industry increase output, cut costs

LINK-BELT equipment—like this bucket elevator—provides dependable, low-cost coal handling in hundreds of power plants all over the country. Regardless of tonnage requirements, Link-Belt offers the right type and size of equipment to unload, store, reclaim and handle many materials with top efficiency.

And, as in so many fields, Link-Belt assumes complete responsibility for the entire installation—from planning to erection, if desired. Whether your job is large or small . . . moving materials or transmitting power—you are invited to investigate Link-Belt's total engineering facilities. Call your nearby Link-Belt sales office.

LINK-BELT

One source . . . one responsibility for materials handling and power transmission machinery

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Sydney; South Africa, Springs. Representatives Throughout the World.

13.343

Another example of how Link-Belt contributes to everyday living: From S. C. Johnson & Son, Inc., Racine, Wis., wax products flow to homes everywhere. Photo at left shows bucket elevator at the Johnson power plant—part of their efficient Link-Belt-engineered coal handling system. Send for Book 2410, describing Link-Belt's range of services and products for modern power plants.

Simplify Maintenance Problems!

USE **SEAMLEX ROTARY**

Triple Protection Against Leakage!

FOR REVOLVING DRUMS AND TILTING KETTLES

3 EXCLUSIVE ENGINEERING FEATURES

- EXTERNAL SCREW ADJUSTMENT
- PRESSURE EQUALIZING CHAMBER
- FLOATING CUPROGRAPHITE SEAL

ensure Lowest Maintenance • Maximum Production • Minimum Power Consumption.

AVAILABLE FROM ⅜" to 2" IPS — SYPHON AND PLAIN TYPE

Ask for Bulletin 5500 Today

SEAMLEX COMPANY, INC.

41-23 24th STREET, LONG ISLAND CITY 1, N.Y.

Manufacturers of Seamlex, the flexible seamless all-metal hose since 1928

Imperial

THE *Finest* TRACING CLOTH

Imperial is known in drafting rooms all over the world as the traditional quality tracing cloth.

With the background of decades of experience, its makers have pioneered in modern improvements to maintain Imperial as the finest tracing cloth made.

CLUTCHES by ROCKFORD

Lifts, Carries and Places Any Size; Shape or Weight

KRANE CAR, built by Silent Hoist & Crane Company, picks up a load of any shape or size, up to ten tons, transports it and spots it accurately, smoothly and safely. ROCKFORD CLUTCHES control the power transmission from its one-man-operated single engine. Let ROCKFORD clutch engineers help with *your* power control problems.

ROCKFORD CLUTCH DIVISION BORG-WARNER

1307 Eighteenth Avenue, Rockford, Illinois, U. S. A.

FORMULA FOR SUCCESS

One proven way to build business is to give customers "extra" service at no extra cost. In ours, the gear business, for example, meeting the customer's requirements entails more than just filling his specifications. We're not satisfied until we've met all our own rigid standards of quality and dependability—no matter how much time and work is involved.

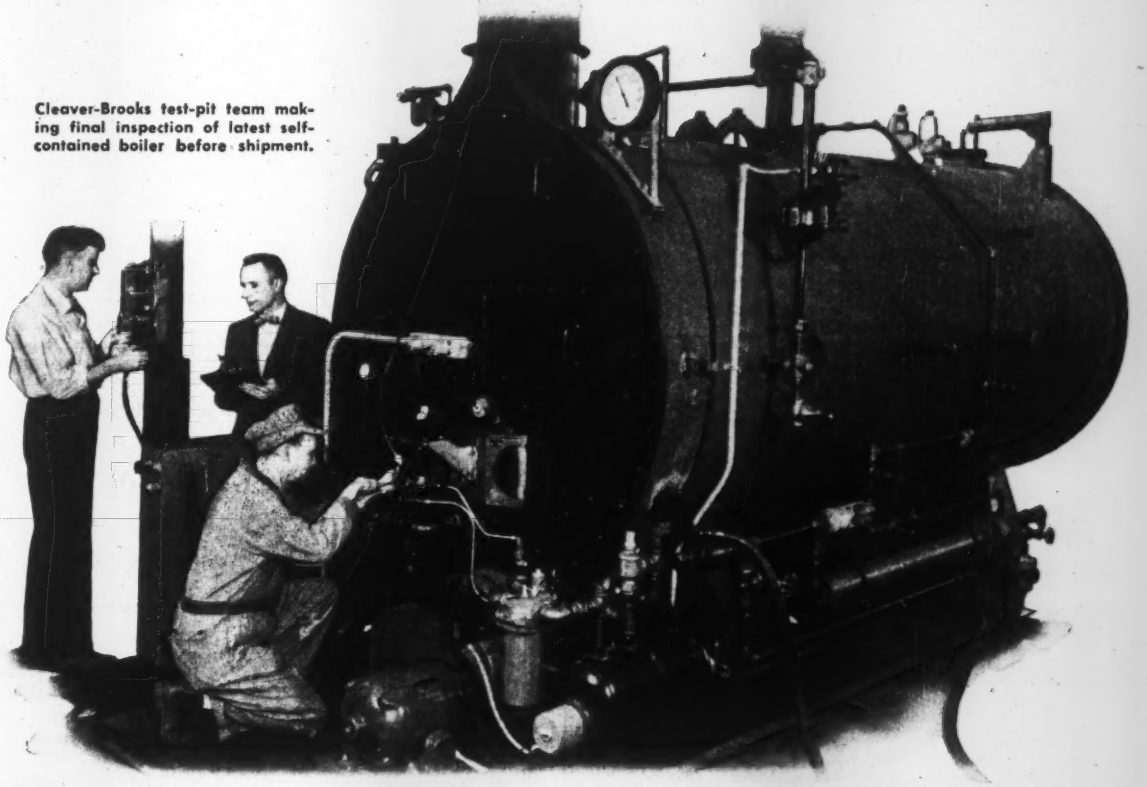
This added effort for each and every customer, we find, helps us keep our old customers and continually bring new ones into the fold. THE EARLE GEAR & MACHINE COMPANY, 4707 Stenton Ave., Philadelphia 44, Pa.

EARLE GEARS

It's good business to do business with EARLE!

their counterpart "Test-Pilots" have at Cleaver-Brooks

Cleaver-Brooks test-pit team making final inspection of latest self-contained boiler before shipment.



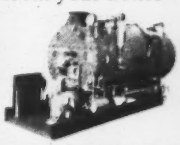
HIGH SCORES . . . on factory and on-job tests guarantee greatest return from boiler investment

When test pilots give the familiar "O.K." — that's the sign of proven performance. It's the same with boilers in the Cleaver-Brooks plant. Only after accurate, thorough inspection and testing under actual operating conditions do boilers get the final "O.K." from experienced test engineers. That's why you get guaranteed 80% efficiency from your Cleaver-Brooks boiler.

A record of this test is available to every buyer on request. In fact, you as a buyer, consultant, or contractor are invited to witness the actual test on your Cleaver-Brooks boiler before shipment.

And further, Cleaver-Brooks boilers are placed in operation at the job site by factory service engineers who check installation, train your operators and make complete and detailed field tests.

So, when you buy a boiler, insist on factory tests as well as field service tests by qualified engineers. There is no better way of insuring yourself of the very best value money can buy and the greatest return from your boiler investment. Look to Cleaver-Brooks, the leader in the "Packaged" Boiler field for two decades. Write today for latest Catalog AD-100.



Available for oil, gas and combination oil/gas firing.

CLEAVER-BROOKS COMPANY
Dept. L, 319 E. Keefe Ave.
Milwaukee 12, Wisconsin, U.S.A.

Cleaver-Brooks

Originators of the Self-Contained Boiler

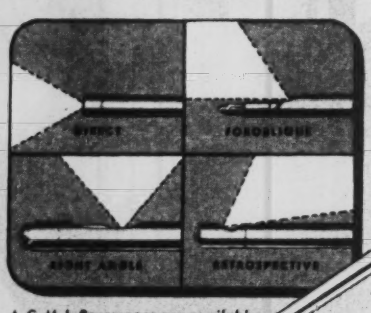
BOILERS — STEAM OR HOT WATER — FOR HEATING AND PROCESSING IN SIZES FROM 15 TO 500 HP, 15 TO 250 PSI

INSPECTION OF CONFINED AREAS FACILITATED

NECESSITY OF DISMANTLING AVOIDED

TIME SAVED—MONEY SAVED

A.C.M.I. BORESCOPES..



A. C. M. I. Borescopes are available in 4 angles of vision (as above) —in diameters of .120" to 4.00"—in lengths of 4" to 720". Special models for special problems.

The A.C.M.I. Borescopes permit close-up visual examination of interior areas and surfaces not otherwise visible. They save time and money, and prevent costly dismantling, by providing a practical solution to a wide variety of inspection problems.

In maintenance and inspection work, on small internal bores, machine parts or castings, to large boiler tubes, chemical plants, process equipment, or other industrial installations, an A.C.M.I. Borescope may be the answer to *your* problem.

Each Borescope is a compact, self-illuminated industrial telescope of highest quality, employing a precision optical system, that produces a flat visual field. Lens systems are fully corrected for color, spherical aberrations, and coma, with all lens surfaces coated to increase light transmission.

Write for free informational folder, or tell us your problem.

American Cystoscope Makers, Inc.

1241 LAFAYETTE AVENUE NEW YORK 59, N. Y.

LEFAX POCKET SIZE TECHNICAL DATA BOOKS $1.25 EACH

Printed on loose leaf, six hole 6¾" x 3¾" bond paper, each book contains about 140 pages of technical data, presenting condensed, accurate and essential data for the student, engineer, technical worker and business man.

Architecture	Metals	Transformers,	Analytic
Home Heating	Gen'l Chemistry	Relays, Meters	Chemistry
Illumination	Reinf. Concrete	Hydraulics	Highway
Electrician's Data	Building Constr.	Surveying	Engineering
Builder's Data	Radio	Mech. Drawing	Pwr. Trans. Mach'y
Lumber Data	Television & FM	Machine Design	Thermodyn. Tbls. & Charts
Air Conditioning	Electricity, AC	Machinists Data	Phys. & Thermodyn. Data
General Math.	Electricity, DC	Piping Data	Phys. & Org. Chemistry
Math. Tables	AC motors and Generators	Surveying Tables	
Physics		Trig-Log Tables	
Chemical Tables		Metallurgy	

Write for FREE Catalog, over 2000 listings. See for yourself how helpful LEFAX can be to you. Send $1.25 for each book, or $6 for any five books listed above, to:

LEFAX Dept. ME-12 Philadelphia 7, Pa.

MECHANICAL ENGINEERING
September, 1953 CARD INDEX Vol. 75, No. 9

Light-Alloy Forging—Design and Production Problems, A. E. Favre ... 693
The Current Status of Engineering Supervision, F. R. Benedict ... 698
Electrospark Machining, C. R. Alden ... 701
Intangible Factors in Engineering Management, C. A. Butler, Jr. ... 706
Metal-Clad Laminates Used in Printed Circuitry, Norman A. Skow ... 709
Air-Pollution Activities ... 712
Panel Extrusions in Aircraft Structures, Howard Kastan ... 715
Developing Engineers Into Executives, Robert F. Pearse ... 719
Editorial ... 691
Briefing the Record ... 723
ASME Technical Digest ... 733
Contents of ASME Transactions ... 740
ASME 1953 Semi-Annual Meeting Preprints ... 741
Comments on Papers ... 743
Books Received in Library ... 745
ASME Boiler Code ... 747
ASME News ... 749
ASME Junior Forum ... 760
Engineering Societies Personnel Service ... 767

MECHANICAL ENGINEERING, 29 W. 39th St., New York 18, N. Y.

Additional information is requested on the following advertisements in the October 1953 issue

Page No. *Name of Advertiser*

Name Title

Company

Address

City State

Reader Service Coupon For More Information

Go through the advertising pages and jot down the page numbers and names of advertisers about whose product you want additional information — mail the coupon to us — your request will be passed on to the advertiser promptly — you will hear directly from advertiser — saves your time in writing individual letters.

PUMPS

for INDUSTRY

HYDRECO

GEAR TYPE PUMPS

Reversible and non-reversible. Gear type pumps in exclusive FOUR-BOLT design . . . capacities from .5 to 130 gpm and operating pressures to 1500 psi . . . flange or foot mounted . . . furnished with keyed shaft with spline shafts optional. Also dual and tandem models.

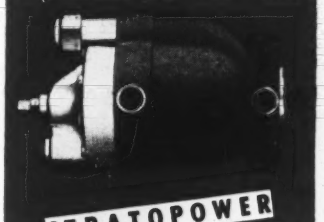
DUDCO

DUAL VANE TYPE PUMPS

DUDCO Pumps provide a broad range of sizes with capacities to 120 gpm and pressures to 2000 psi. Also available in dual units operating from a single drive. Hydraulic motors with starting torque outputs to 14,000 lb. in.

FLUID POWER PUMPS

The most comprehensive range of types, capacities and pressures in Hydraulic Pumps for industrial equipment, presses, machine tools, materials handling, metal working, mining, petroleum, gas and aviation applications. Hydraulic Motors, Cylinders and Valves to develop complete Hydraulic circuits.



STRATOPOWER

PISTON TYPE PUMPS

Axial reciprocating piston type ...constant or variable delivery with capacities of .25 to 10 gpm at nominal speeds of 1500 rpm with maximum of 4500 rpm... working pressures to 3000 psi ...direct engine and individual electric motor driven models.

LIQUID HANDLING PUMPS

An exceptionally broad range of types, sizes and special constructions to handle virtually "any substance that will flow through a pipe" including: syrups, acids, sludges, slurries, asphalt, bunker fuel, etc.

KINNEY

LIQUID HANDLING PUMPS

A complete range of sizes in Rotating Plunger and Herringbone Gear Pumps to handle light or heavy liquids from gasoline to molasses. Available in plain or steam jacketed models.

VACUUM PUMPS

High Vacuum Pumps for laboratory, electronic, atomic research, biological and other chemical processing, vacuum refining of metals, de-aerating, dehydration, vacuum drying, refrigeration, etc.

Write for full information ➘

KINNEY

VACUUM PUMPS

Single stage models to produce absolute pressure readings of 10 microns (.01 mm Hg.) ... compound pumps producing readings of .2 microns (.0002 mm Hg.) or better. These Kinney High Vacuum Pumps are available in sizes for laboratory as well as high production use.

AURORA

CENTRIFUGAL & TURBINE PUMPS

Deep well, sump, drainage and condensation return units, household water systems. Industrial low and high pressure liquid handling pumps. Direct motor and countershaft driven horizontal and vertical models. Capacities 3 to 7500 gpm.

THE NEW YORK AIR BRAKE COMPANY

230 PARK AVENUE • NEW YORK 17, N. Y.

THE NEW YORK AIR BRAKE COMPANY
230 Park Ave., Dept.ME-1, New York 17, N. Y.
Gentlemen: Kindly send additional information on the pumps I have checked.

☐ Hydreco Pumps ☐ Kinney Liquid Handling Pumps
☐ Stratopower Pumps ☐ Kinney Vacuum Pumps
☐ Dudco Pumps ☐ Aurora Pumps

Name_____
Address_____
City_____ State_____

FRICTION-FREE
DeZURIK VALVES

DeZurik Easy-Operating Plug Valves offer 100% friction-free service on any line. In opening the valve, the slightest movement of the lever lifts the rubber plug-face entirely free of the eccentric valve seat; completing the quarter-turn swings the plug out of the way — smoothly, easily, WITHOUT FRICTION! The plug-face does not come into contact with ANY PART of the valve body except at the moment of closure. No friction means no binding or scoring; there's no lubrication needed, and virtually no maintenance. Get the complete story on DeZurik Easy-Operating Plug Valves in all sizes and metals. Write for data.

DeZURIK SHOWER CO.
SARTELL, MINNESOTA

AIR • GAS • AMMONIA / compressor operators

DID YOU KNOW...

you can build peak performance into your oldest compressors!
and obviously into your newer, high speed machines, too!

INSTALLATION OF VOSS VALVES WILL DO THE JOB!

if you want peak performance **. . . increased efficiency . . . greater output . . . lower power costs with utmost safety, investigate the advantages of VOSS VALVES for your machines.**

VOSS VALVES provide. **. . . Quiet, vibration-free operation • 20 to 60% more valve area • less power consumption • low pressure loss • normal discharge temperature • lower operating costs • utmost safety.**

To increase the efficiency of your compressor, send us the name, bore, stroke and speed of your machine. Our detailed proposal will be sent without obligation.

VOSS VALVES

J. H. H. VOSS CO.
INCORPORATED

787 East 144th Street, New York 54, N. Y.

Useful References for Your Library

• URANIUM, PLUTONIUM AND INDUSTRY

This booklet outlines the Atomic Energy Commission's production program, sketches the research and development network, discusses applications of atomic energy, and lists sources of information on the atomic energy field.
1952 $1.50

• DEFINITIONS OF OCCUPATIONAL SPECIALTIES IN ENGINEERING

This occupational information book contains current and comprehensive data related to activities such as research, design, development, testing, procurement, production, construction, operation, administration and teaching, and to twenty-three engineering fields of specialization, including the special knowledge, duties, responsibilities and related techniques necessary. The definitions—approximately 500—were prepared by the ASME with the assistance of representatives of pertinent engineering societies.
1951 $2.50

• BIBLIOGRAPHY ON PLASTICITY, ITS THEORY AND APPLICATIONS

In this Bibliography are 1845 chronologically arranged references to practically all important articles on the theory of plasticity, particularly of metals, and on its application to engineering problems. The references have been culled from books and periodicals published in the U. S. and other countries from 1835 to 1949. Subject and author indexes are included.
1950 $2.25

• BIBLIOGRAPHY ON THERMOSTATIC BIMETALS, LOW-EXPANSION ALLOYS, AND THEIR APPLICATIONS

The 302 annotated references in this Bibliography cover the historical developments from the early eighteen hundreds; the use of various materials; the studies of the anomalous expansion properties of the nickel steels; surveys of theoretical and practical design; applications in thermostats, in chronometers and watches, for heated spaces, furnaces and motors.
1950 $1.00

• MANUAL OF CONSULTING PRACTICE

This Manual recommends the general basis for consulting work, classifies consulting services, deals with designation of mechanical engineering projects, cost of rendering service, types of service, basis for making charges, repetitive work, drawing and designs, patterns and confidential data.
1941 $ .50

20% Discount to ASME Members

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 WEST 39TH STREET, NEW YORK 18, N. Y.

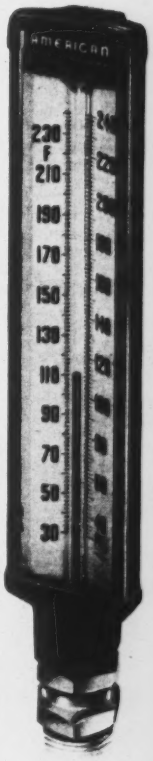
Bronze Extrusion makes a stronger sales case for this industrial glass thermometer

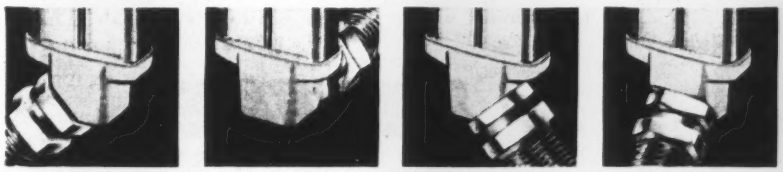
The case for this "American" Industrial Glass Thermometer made by Manning, Maxwell & Moore, Incorporated, Stratford, Conn., used to be a steel stamping. Now it's made of ANACONDA Extruded Bronze.

Why the change? Because this extruded bronze shape makes a far stronger and more rigid case; it's easier to produce; it simplifies assembly—and adds additional quality to an already high-quality product. So accurate are these bronze extrusions that neither straightening nor machining is needed for assembly. And assembly time itself is cut.

For the base, an ANACONDA Brass Die Pressed Forging is joined to the case by brazing to provide greater joint strength. By machining the appropriate face of a single-style base forging, a stem connection can be provided at any angle.

ANACONDA Brass and Bronze have long been making a stronger "case" for products—by simplifying production; by the higher quality that is always associated with products made of brass or bronze; by increasing sales appeal. We urge you to consider the advantages of these metals for your manufacturing processes and your products. For information, write to The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

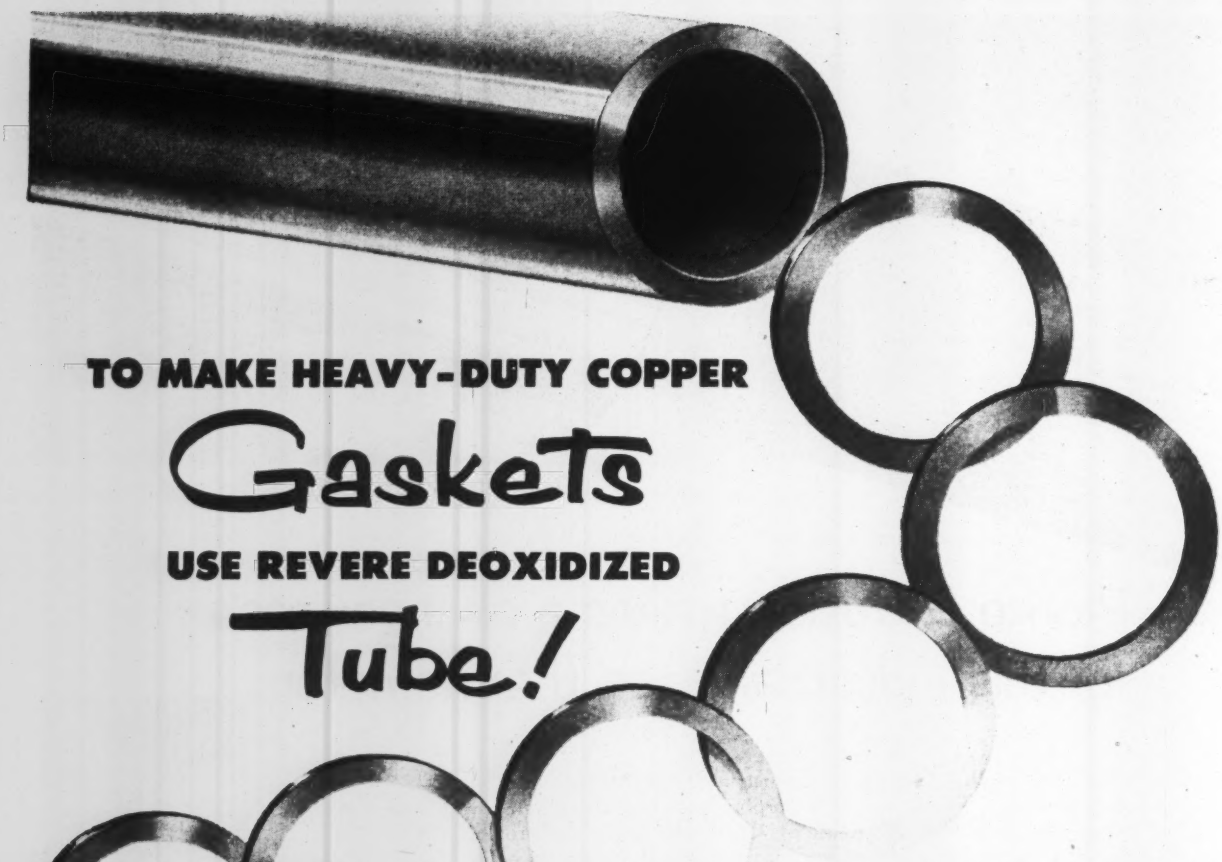




Base forging can be machined to provide stem connection at any angle and direction.

Extruded case and forged base for this 9-in. "American" Thermometer are joined in perfect alignment by brazing. No machining or straightening is required.

ANACONDA® —the name to remember in **COPPER—BRASS—BRONZE**

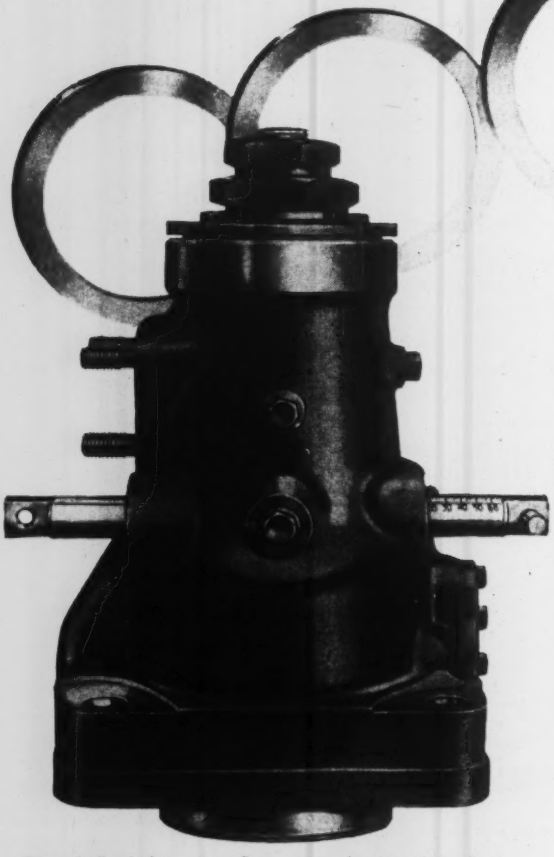


TO MAKE HEAVY-DUTY COPPER

Gaskets

USE REVERE DEOXIDIZED

Tube!



Diesel Fuel Injection Pump, made by American Bosch Corp., Springfield, Mass., and gaskets made by cutting rings off 2" deoxidized copper tube.

• An important extra service rendered by Revere consists of collaboration in setting up specifications. This is valuable because there are many different Revere Metals, each with special characteristics. No one copper, for example, will serve to best advantage in every application. A case in point is the matter of copper gaskets for Diesel fuel injection pumps. Copper is of course an ideal metal for gaskets, and is widely used for that purpose. But for this special application, which copper and in what form? The pump is used on large engines for municipal generating plants. It weighs 186 pounds, and must produce the high pressure required to inject fuel near the top of the Diesel compression stroke. Naturally, the load is a pulsating one. American Bosch Corporation came to Revere with the problem. Our suggestion was that much scrap could be saved if the gaskets were made by cutting rings off copper tube, instead of stamping them from strip. This achieved a double purpose, since the tube is made of deoxidized copper, which is superior in this application to electrolytic. We are able to report that these recommendations proved successful. . . . This work was done by the Revere Technical Advisory Service. To get in touch with it, see the nearest Revere Sales Office.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

•

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.— Sales Offices in Principal Cities. Distributors Everywhere.

SEE REVERE'S "MEET THE PRESS" ON NBC TELEVISION, SUNDAYS

Representatives—Sales Agencies
Business for Sale
Partnership—Capital
Manufacturing Facilities

OPPORTUNITIES

Positions Open—Positions Wanted—Equipment, Material, Patents, Books, Instruments, etc. Wanted and For Sale

Answers to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

POSITIONS OPEN

CHIEF MECHANICAL INSPECTOR

Mechanical Engineer preferred, with broad background in mechanical installation and operation. Must have responsible experience as Inspector of mechanical installations on large industrial projects. Central station steam power plant experience desirable.

Bechtel Corporation
220 Bush Street San Francisco, Calif.

AUTOMATIC WASHER COMPANY
NEWTON, IOWA

Positions now open for highest quality personnel. Liberal policies on vacation, insurance, etc. Specialized job training offered.

Junior Engineer, Mechanical. Graduate or man of equivalent mechanical understanding.

Design, Development Engineer, Mechanical. At least 5 years' experience in engineering major home appliances or similar for quantity production. Must understand basic engineering and design, manufacturing operations, tolerances, finishes, etc. Electrical knowledge helpful. Age range 28 to 40.

Write to
Mr. W. C. Bruckman
Vice President
In Charge Of Engineering

ENGINEERS

A prominent Cleveland, Ohio, manufacturer is actively seeking engineers who wish to permanently associate with a progressive leader in the hydraulics and fluid systems field. Some of the excellent openings are in:

PRODUCT DESIGN—Experience in Hydraulic equipment design and complete follow-up.

APPLICATION ENGINEERING—Experience in design of Machine Tool Hydraulic Control systems.

PROJECT ENGINEERING—Experience in design and development of Hydraulic Pumps or Machine Tool Hydraulic system valves and other components.

TOOL DESIGNERS AND DRAFTSMAN—Salary commensurate with ability; many company paid benefits. Please write giving full details of experience; education, and salary requirements.

Address CA-4470, % "Mechanical Engineering."

RATES Classified Advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of $1.70 a line. $1.35 a line to members of ASME. Seven words to the line average. A box number address counts as one line. Minimum insertion charge, 5 line basis. Display Advertisements carried in single column units of multiples of one inch at flat rate of $28 per inch per insertion. Copy must reach us not later than the 10th of the month preceding date of publication.

WANTED MECHANICAL ENGINEERS

Established consulting firm, New York area, desires Mechanical Engineers, capable supervising starting, testing, operating and correcting troubles of steam electric station equipment. Plant betterment work involving considerable travel. Technical education and plant operating or betterment experience required. State education, experience and salary desired.

Address CA-4417, % "Mechanical Engineering."

PRODUCT DESIGNERS AND DRAFTSMEN

Internationally prominent manufacturer of heavy machinery used in mining, crushing, cement and basic processing industries, located Midwest, has excellent opportunities for Mechanical Design Engineers and Draftsmen for research and development and new product design. Liberal employee benefits, plus exceptionally fine working conditions and opportunity for future. Write, stating experience, present employment, personal data and salary expected. Replies confidential.

Address CA-4437, % "Mechanical Engineering."

Use a CLASSIFIED ADVERTISEMENT
For QUICK RESULTS

MECHANICAL ENGINEER

To be Plant Engineer in small chemical plant in small Michigan town. Work includes responsibility for maintenance, construction and steam generation. Prefer man 30-35 with supervisory experience. Good opportunity for young engineer who wants responsibility. Salary dependent on experience.

Sumner Chemical Company, Inc.
Zeeland, Michigan

We are seeking a responsible man to fill the position of

MACHINE DESIGNER

for automatic machine design in the central Research & Development Department of a national paper converter. We do not want first *a* man; we want *the* man, preferably one with a mechanical engineering degree and over 8 to 10 years' experience practicing phases of machinery design and a record of successful designs. *The* man can think creatively and is well founded in mechanics. A knowledge of the paper industry would be helpful, of course, but it is not required.

To get this man, we offer a good salary, relaxed living conditions away from the metropolitan bustle, a complete range of company benefits, and a challenging future with an expanding company.

If you are interested, please send a resumé of your experience, your personal history, and an idea of your salary requirements. Your inquiry will be kept confidential.

Address CA-4477, % "Mechanical Engineering."

PROJECT MANAGER
power plants

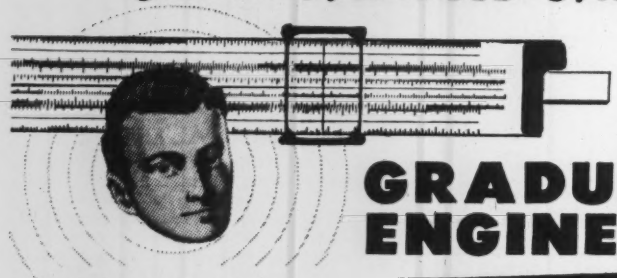
Internationally known engineering organization, located on the East Coast, requires the services of a graduate ME with a minimum of 10 years' experience in the design and development of chemical, oil refinery or other large industrial power plants.

This is a permanent, top-level position and offers a high salary an unusually liberal pension plan and vacation policy, and executive insurance. Traveling and moving expenses will be paid.

Please submit complete details of education, background, experience, past salaries, and initial salary requirements. Our personnel have been advised of this opening.

Box 116, Room 1201
230 West 41st St., New York 36, N. Y.

Still the Wise Choice



for

GRADUATE ENGINEERS

DU PONT

Positions are now open in the following fields as well as numerous others:

Instrumentation
Power
Process
Machine Development
Mechanical Research
Electrochemicals
Textile Equipment

Today, as in the past, engineers look upon du Pont as a better place to build a solid future. This is not surprising. For, as a du Pont engineer, they enjoy the prestige of working with one of America's great industrial leaders; the stability inherent in its over 1200 products serving more than 20 different fields; the vast resources of its 76 plants and 40 laboratories throughout the country; and the challenge and opportunity provided in an expanding industry.

Please do not apply if you are utilizing your highest skills in defense industry.

Please send complete resume to Mr. W. N. Nesbitt
Engineering Dept., Personnel Section

E. I. du Pont de Nemours & Co., Inc.
Wilmington, Delaware

---

mechanical engineers

General Electric Offers Opportunities In The Design and Development of Electronic Products

Continuing expansion of General Electric's Electronics Division has created new openings for qualified Mechanical Engineers. These assignments—available immediately—are for design and development work on electronic product lines which include:

Television and Radio Receivers
Automatic Machines
Military Radio and Radar Equipment
Cathode-Ray Tubes
Components for Electronic Equipment

This is stimulating and challenging work, involving a wide range of interesting engineering problems in such varied fields as:

servo-mechanical and remote control • printed circuits • heat transfer • mechanization of process or assembly • shock and vibration • machine design • product design • antenna structure

For these career positions, the minimum requirement is a B.S. in Mechanical Engineering, or the equivalent in experience. Engineers with degrees in other fields, who have a strong interest in mechanical design problems, may also qualify.

A General Electric career offers many advantages to ambitious and creative engineers:

permanent employment with a leading company . . . steady advancement . . . finest facilities and equipment . . . diversified pioneering projects . . . association with leading engineers . . .

PLUS

pensions . . . life insurance . . . paid vacations . . . surgical and hospitalization benefits . . . educational subsidies . . . and others.

Write: Technical Personnel

GENERAL ELECTRIC

P.O. BOX 1122 SYRACUSE, N. Y.

MECHANICAL ENGINEERS

CAREER OPPORTUNITIES

Small Company atmosphere with large Corporation advantages. Assignments now available for engineers qualified in the field of mechanical design.

- **Layout & over-all system design**
- **Basic System Design**
- **Detailed Design of Ordnance Equipment**
- **Stress Analysis of Mechanical Equipment and Structures**

Suburban location adjacent to Washington, D. C., affords pleasant living conditions and is accessible to 4 universities offering graduate courses. Reasonable relocation expenses.

All replies confidential.

Please forward resumé to

Personnel Department

Silver Spring Laboratory

VITRO CORP. OF AMERICA

962 Wayne Ave., Silver Spring, Md.

ENGINEERS—For professorships all engr. fields, Master's and Doctor's qualify unusually fine positions, $4500-7000 nine months. Instructors, bachelors. Give phone, photo, qualifications. Cline Teachers' Agency, East Lansing, Mich.

MECHANICAL ENGINEER—for dual position as Power Plant engineering teacher and Superintendent of college heating plant. Must have steam plant experience. Contact R. A. Adams, Sup't., Physical Plant, Oregon State College, Corvallis, Oregon.

ENGINEER—Mechanical—Graduate or equivalent to do all engineering in a small department handling installation and maintenance of wood working machinery, boiler plants, cranes, pumps, and process equipment. Part office and part field. Permanent. Location—Louisville, Ky. Give age, qualifications and recent earnings first letter. Address CA-4462, care of "Mechanical Engineering."

MEDICAL ENGINEERING—Combination advanced degree work in Johns Hopkins Engineering School; instrument design and execution; theoretical and experimental analysis of complex vibrations problem in ballistocardiography project. Write full qualifications, experience, salary level, to Dr. S. A. Talbot, Johns Hopkins Hospital, Baltimore 5, Md.

MECHANICAL ENGINEER—Sound, Resourceful Engineer to Supervise the construction and assembly of new type, highly mechanized Electric melting furnaces. Experience in the following: The purchase of construction components, site and preparation and final assembly is required. You will work in a challenging new metal producing Industry. Permanent Position, Excellent Growth Prospects, Liberal Benefits, Salary Open. Give complete resumé of Education and Experience. Write: Rem-Cru Titanium Inc., Midland, Penna., Att: J. F. Varley.

SALES ENGINEERS—Openings available with large industrial instrument manufacturer for field Sales Engineers in New York, Chicago, Pittsburgh, Houston, and St. Louis areas. Graduates of recognized engineering colleges with training in electronics preferred. Mechanical and Chemical Engineers will also be considered. Excellent opportunity for young engineers with sales aptitude who wish to enter the fast-growing industrial instrument field with a long established and rapidly growing manufacturer of industrial instruments. Address CA-4491, care of "Mechanical Engineering."

Additional Opportunities are offered in the display advertisements—

on pages 51, 58, 62, 65, 76, 136

TECHNICAL PERSONNEL

looking for opportunities in

ATOMIC ENERGY

ENGINEERS

- MACHINE DESIGN
- ELECTRICAL POWER DESIGN
- HEATING AND VENTILATING
- PROCESS INSTRUMENTATION DESIGN
- CONSTRUCTION DESIGN AND LIAISON
- PRESSURE VESSEL AND EQUIPMENT INSPECTION
- PROCESS ANALYSIS—MATHEMATICAL AND STATISTICAL
- CHEMICAL ENGINEERING DESIGN, RESEARCH, AND DEVELOPMENT

MATHEMATICIANS AND STATISTICIANS

- ENGINEERING OR PHYSICAL SCIENCE BACKGROUND DESIRABLE

METALLURGISTS

- PHYSICAL AND PROCESS

Qualified graduates with 0–8 years' experience
Send resumé and salary information to
TECHNICAL PERSONNEL OFFICE

CARBIDE AND CARBON CHEMICALS COMPANY
a division of
UNION CARBIDE AND CARBON CORPORATION
POST OFFICE BOX P, OAK RIDGE, TENNESSEE

CHIEF MECHANICAL ENGINEER

Age 30 to 40

For immediate employment with leading manufacturer of industrial valves. Plant located in Oakland, California, is complete manufacturing division of long established national company.

M.S. in mechanical engineering essential. Must have thorough knowledge in machine design, strength and determination of materials, thermodynamics, fluid flow (gas and liquid), engineering economics. Applicant must be fully qualified to assume complete technical and administrative responsibilities for the Mechanical Engineering Department.

Excellent opportunity for an applicant meeting above requirements and possessing outstanding ability and imagination. Please reply, stating education, experience and references, expected salary, residence telephone number. Attach recent snapshot or photo. All replies strictly confidential. Address replies to Industrial Relations Department.

Rockwell Manufacturing Company
Nordstrom Valve Division
2431 Peralta Street
Oakland 7, California

Exceptional Opportunities for . . .

electrical engineers

mechanical engineers

mechanical designers

•

in the field of electronic computers and associated equipment for use in business machines.

Write, giving education and experience to Employment Manager.

Reply to Department C.

THE NATIONAL CASH REGISTER COMPANY, Dayton 9, Ohio

POSITIONS OPEN

Continued from Page 151

MECHANICAL ENGINEER

Nationally known Consulting Engineering Firm has an excellent opportunity for a Mechanical Engineer to supervise a Design Department engaged in diversified work involving power plants, chemical plants, research laboratories, industrial buildings and facilities, etc. Good background in administration and design required. Prefer graduate ME, age 40–50, Midwest.

Address CA 4438, % "Mechanical Engineering."

MECHANICAL ENGINEER

Nationally known Consulting Engineering Firm offers an excellent opportunity for a Mechanical Engineer to supervise design in the Heating, Ventilating, and Air Conditioning Section of its Mechanical Department. Involves work on power plants, chemical plants, research laboratories, industrial buildings and facilities, etc. Prefer graduate ME, age 35–45. Midwest.

Address CA-4439, % "Mechanical Engineering."

ENGINEERS—Experienced in Catapult or Similar Equipment. Also ENGINEERING TRAINEES

Aircraft Catapult and arresting gear dept. in AAAA midwest firm has permanent positions in design section. Experience in hydraulic machinery and similar mechanical equipment now being manufactured by this newly-organized dept. may become basic ground gear for modern high-speed planes, both military and civilian.

This 100-year-old firm pays top wages and provides many other benefits. Imaginative engineers, aged 25 to 40, interested in this expanding field should send resumé.

Address CA-4485, % "Mechanical Engineering."

ENGINEERING POSITION AVAILABLE

College engineering graduate preferably with mechanical engineering degree, required for experimental design and stress analysis work in Midwest area by a large manufacturer of power transmission equipment. Some background in design work and operation of instruments desirable. Opportunity for advancement. All replies confidential.

Address CA-4487, % "Mechanical Engineering."

EMPLOYMENT AGENCIES AND SERVICE BUREAUS

ENGINEERS AND EXECUTIVES—This confidential service for outstanding men who desire positions paying $5,000 to $40,000 will develop preliminary negotiations with reputable organizations without risk to present position. For complete details, send experience record and expected salary range. Tomsett Associates, 337 Frick Bldg., Pittsburgh 19, Pa.

PLANT PERSONNEL, ENGINEERS, DESIGNERS—Draftsmen, Chemists, and Metallurgists, E. G. Stroud, Member ASME and President of Cleveland Engineering Agency Co., 2132 E. 9th St., Cleveland 15, Ohio, will help you find positions or men.

SALARIED PERSONNEL $3,000—$25,000

This confidential service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions, assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited.

JIRA THAYER JENNINGS
Dept., J, 241 Orange Street, New Haven, Conn.

SALARIED POSITIONS $3,500 to $35,000. We offer the original personal employment service (established 43 years). Procedure of highest ethical standards is individualized to your personal requirements. Identity covered; present position protected. Ask for particulars.

R. W. BIXBY, INC.
115 Dun Bldg. Buffalo 2, N. Y.

INVENTIONS

WRITE for information about service for selling inventions. Patent Engineering Development Co., 617 Pioneer American Building, Houston, Texas.

REPRESENTATIVES AVAILABLE

MANUFACTURERS REPRESENTATIVE—Engineering background. Mechanical, electro mechanical, refrigeration. Metropolitan New York. Address CA-4410, care of "Mechanical Engineering."

POSITIONS WANTED

ADMINISTRATIVE MECHANICAL ENGINEER

Channel your design hours for maximum effectiveness.

Address CA-4469, % "Mechanical Engineering."

MECHANICAL ENGINEER—BSME, MIT, 23, Single, 3 years' experience construction, power and processing equipment design, desires foreign employment upon completion tour duty as Lt., Army Corps of Engineers, July, 1954. Versatile, prefer field position. Address CA-4465, care of "Mechanical Engineering."

MECHANICAL ENGINEER—27, B.S. 1949, Navy Veteran, 2 years' power plant maintenance, testing, operation. 2+ yrs. regulator mfgr., development, trouble-shooting, testing, application. Desires technical sales position utilizing background. Address CA-4471, care of "Mechanical Engineering."

MECHANICAL ENGINEER—B.M.E., Registered P.E. (N.Y.). Age 31. 10 years' diversified experience. Project engineer petroleum and chemical plants; experienced all phases project management. Also intensive work in the design and application of heat transfer equipment. Address CA-4472, care of "Mechanical Engineering."

MECHANICAL ENGINEER—Graduate, age 29, married, 3 years' diversified experience and training in design, testing, production, and sales, 4 years', pre-college, as mechanic. Seeks position with future. Present salary $5650. Address CA-4474, care of "Mechanical Engineering."

MECHANICAL ENGINEER—M.S. in Mathematics, 30, 5 years' diversified experience in Vibration, Stress Analysis, Gas Turbines. Desire theoretical and/or experimental position in field of vibrations, electromechanical transducers, ultrasonics, with progressive company in N.Y.-Phila. area. Address CA-4475, care of "Mechanical Engineering."

MECHANICAL ENGINEER—BSME, MSME, PE. Senior Engineer 5 yrs.' experience in development, research, teaching of heat transfer, fluid flow. Ph.D. Cand. Desires responsible position in heating, air conditioning, refrigeration. Chicago area preferred, Foreign considered. Address CA-4476, care of "Mechanical Engineering."

MACHINE DESIGNER—Investigating opportunities connected with design and development programs, Chicago area. Desire position associated with long range opportunities to advance, commensurate with demonstrated ability and talent. Capable of original and independent design work on small and medium class automatic machinery. Proven ability, ambitious, age 33, B.S.-M.E. degree, five years' experience as designer. Address CA-4478, care of "Mechanical Engineering."

EXECUTIVE ENGINEER—desires connection with medium size company to assume full responsibility as Production Manager, Chief Engineer or Staff Assistant. 25 years' of unique practical, design, manufacturing and sales experience in the automatic machinery and precision instrument field. Thoroughly familiar with engineering and developing new products, cost conscious, capable organizer. Age 51. College Graduate ME. Present salary $15,000—plus bonus. West Coast Location preferred. Address CA-4480, care of "Mechanical Engineering."

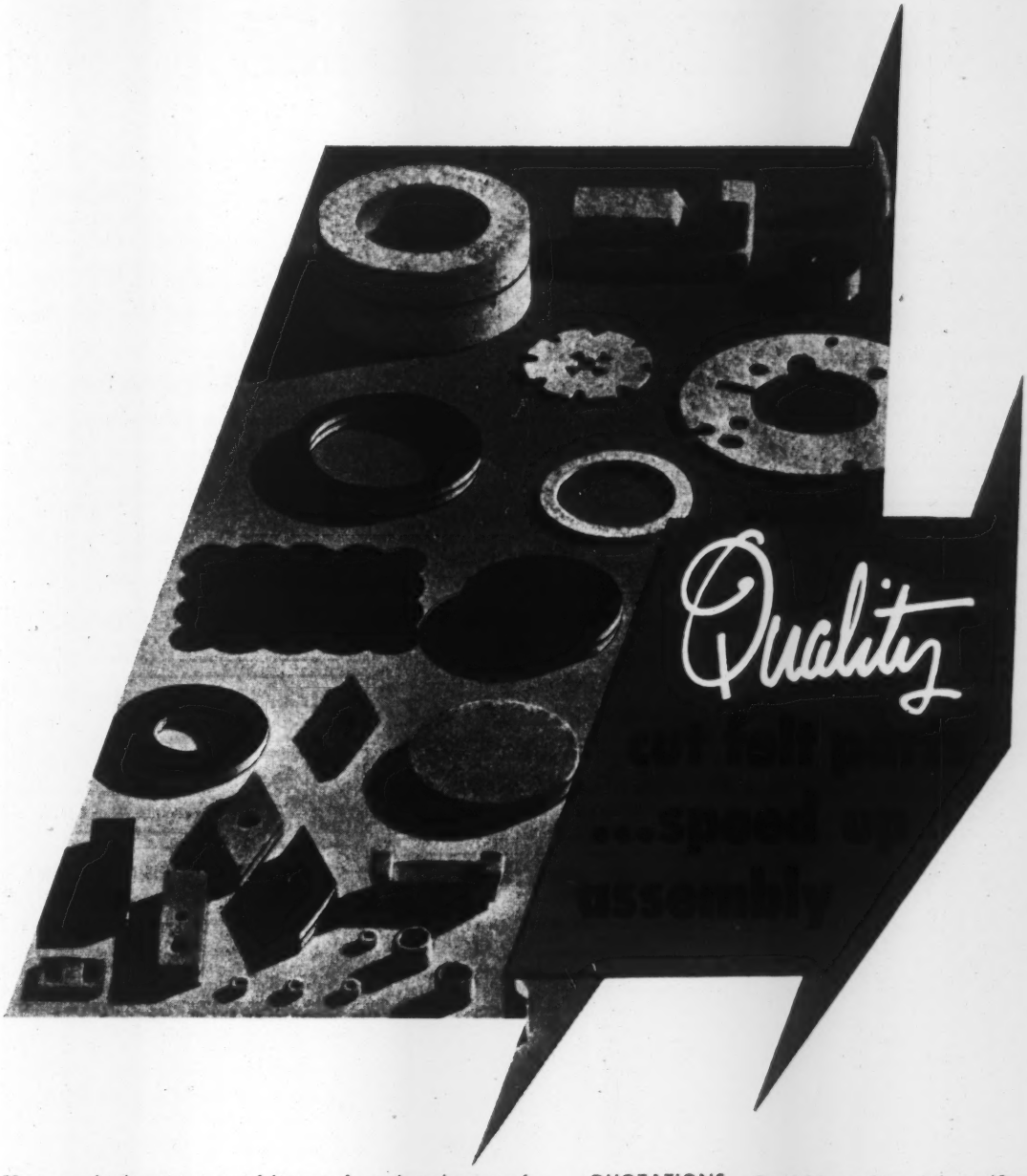
MECHANICAL ENGINEER—Mass. Reg. P.E. many years' broad experience with internationally known company in design and installation of steam, hydro, diesel power, water supply, drainage and irrigation pump plants, materials handling, refrigeration, industrial, processing plants, etc., approaching retirement. Will entertain limited amount of part time consulting, supervising, design or investigation report work within reasonable commuting distance of Metropolitan Boston. Address CA-4489, care of "Mechanical Engineering."

ENGINEER FOR JAPAN—Industrial, Mechanical and Construction experience. Available at once for return Japan in plant, install-service, design, sales promotion, field inspection. Write Phillips P. Smith, Box 52, Main Postoffice, San Francisco, Calif.

ADMINISTRATIVE ENGINEER & PLANT MANAGER—Mechanical Engineer with excellent record of engineering and business management ability; 18 years' experience; machinery, process, plant equipment, air handling; purchasing, manufacturing, sales, financial. Address CA-4445, care of "Mechanical Engineering."

It will pay you to read the announcements on these pages for an opportunity that you may be looking for or one that may be of interest to you.

Every Advertiser appearing in MECHANICAL ENGINEERING believes . . . . that his products . . . the service in them and the service behind them . . . will stand up under the most searching scrutiny of the high calibre engineers and executives comprising MECHANICAL ENGINEERING readership.



You can obtain custom-cut felt parts from American, ready for assembly without further processing. Gaskets, washers, seals, wicks, discs—any shape you need, simple or complicated, can be turned out by us on high-speed machines, with tolerances to meet your specifications.

QUICK DELIVERY —American operates four strategically-located cutting shops to serve industry. The one nearest you will fill your order rapidly. Cutting shops are located at:

GLENVILLE, CONN. DETROIT, MICH.
LOS ANGELES and SAN FRANCISCO, CALIF.

These are manned and managed by men who will see that your production is never slowed up by lack of cut felt parts.

QUALITY —American produces felt to exact specifications, uniform in density, blend, thickness, strength. This is an engineering material which can be controlled as closely as any other. If you wish, we will cooperate with you in designing felt parts and specifying the right felt to meet your exact requirements, whether for commercial or government applications.

QUOTATIONS —Send blue prints and specifications to the nearest Sales Office. Bids will be made at once.

AMERICAN CUT FELT PARTS MAKE IT UNNECESSARY FOR YOU TO INVEST IN MACHINERY AND TRAIN MEN TO CUT FELT TO YOUR SPECIFICATIONS.

American Felt Company

TRADE MARK

GENERAL OFFICES: 50 GLENVILLE ROAD, GLENVILLE, CONN.

SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, San Diego, Montreal — PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I. — ENGINEERING AND RESEARCH LABORATORIES: Glenville, Conn.

RATES One Inch Card Announcements Inserted at rate of $20.00 each issue, $15.00 per issue on yearly contract.

CONSULTING SERVICE

Manufacturers of Equipment Not Included

BLACK & VEATCH
CONSULTING ENGINEERS
Electricity—Water—Sewage—Industry
Reports, Design, Supervision of Construction
Investigations, Valuation and Rates
4706 Broadway — Kansas City 2, Missouri

PETER F. LOFTUS CORPORATION
Engineering and Architectural Consultants and Designers
First National Bank Bldg.
Pittsburgh 22, Pennsylvania
Cable Address–"LOFTUS Pittsburgh"

Consult **Z. H. POLACHEK**
Reg. Patent Attorney
1234 Broadway
(at 31st St.) New York 1, N. Y.
Phone LO-5-3088

Electrical Testing Laboratories, Inc.
Electrical, mechanical, photometric, radiometric and chemical laboratories, rendering testing, research and associated services, including certification, inspections at factories and field investigations.
2 East End Avenue at 79th St., New York 21

PIPING DESIGN DIVISION
MARQUETTE COPPERSMITHING CO.
Piping Flexibility—Structural Components
Vibrations—Scale Model Tests
Analyses—Reports—Field Service
Ask for Bulletin PDD-4
(Est. 1888)
P.O. Box 4548 — Philadelphia 31, Pa.

SANDERSON & PORTER
ENGINEERS & CONSTRUCTORS
New York • Chicago • San Francisco

HARZA ENGINEERING COMPANY
CONSULTING ENGINEERS
L. F. Harza
E. Montford Fucik — Calvin V. Davis
Hydroelectric Plants and Dams
Transmission Lines
Flood Control, Irrigation
River Basin Development
400 West Madison Street — Chicago 6

research and development
product engineering and styling
special production machines
model building
write for brochure
MAST DEVELOPMENT CO. INC
2212 E. 12th St. — DAVENPORT, IOWA

Power Plants, Structures
Transmission Systems
Design, Supervision, Inspection
Appraisals, Reports
SARGENT & LUNDY
140 S. Dearborn St., Chicago, Ill.

C. M. HATHAWAY
CONSULTING ENGINEER
Project Engineering, Product Development, Production Designs, Laboratory and Shop Facilities for Research, Model Work, and Pilot Manufacturing
1315 S. Clarkson Street — Denver 10, Colorado

WELD TESTING
Qualification of Operators—Supervision
Inspection—Research
NATIONAL WELD TESTING BUREAU
Pittsburgh Testing Laboratory, Pittsburgh, Pa.

J. E. SIRRINE COMPANY
Engineers
Design and Supervision of Steam and Hydro-electric Power Plants. Industrial Plants, Mechanical and Operating Surveys, Appraisals • Plans • Reports
Greenville, South Carolina

JACKSON & MORELAND
Engineers and Consultants
Utilities and Industrials
Design and Supervision of Construction
Reports—Examinations—Appraisals
Machine design—Technical Publications
BOSTON — NEW YORK

NUCLEAR DEVELOPMENT ASSOCIATES, Inc.
—NDA—
Consulting Physicists, Mathematicians, and Engineers. Studies in Analytical Engineering and Mathematical Physics
80 Grand Street — White Plains, N. Y.
WHite Plains 8-5800

STANLEY ENGINEERING COMPANY
CONSULTING ENGINEERS
Power Plants
Steam - Diesel - Hydro
Design - Construction - Test - Valuation Surveys
Hershey Building — Muscatine, Iowa

GEORGE H. KENDALL
Consulting Mechanical Engineers
Methods Studies: Process of Product Redesign Existing Products for Greater Profit
Trouble Shooting Production, Design, Cost Problems, Specialist Automatic Machinery Processes, Controls, New Developments, Patent Studies, Investigations. New Products & Process Engineering Studies.
P. O. Box 3 (*Est. 1921*) Tel. Darien 5-1504
Noroton Heights — 3 Offices — Darien, Connecticut

DELOS M. PALMER & ASSOCIATES
CONSULTING ENGINEERS
Reg Mechanical, Electrical & Industrial Designers of Special Purpose Machines
Product Development
Laboratory and Model Work
4401 Jackman Rd. — Toledo 12, Ohio

MECHANICAL - MANAGEMENT - ELECTRONIC
PROCESS - DESIGN - QUALITY - CONTROL
INVESTIGATIONS - APPRAISALS - REPORTS
JOHN I. THOMPSON & COMPANY
ENGINEERS
921-17th ST., NW Washington 6, D. C.
LABORATORY DIVISION — BELLEFONTE, PA.

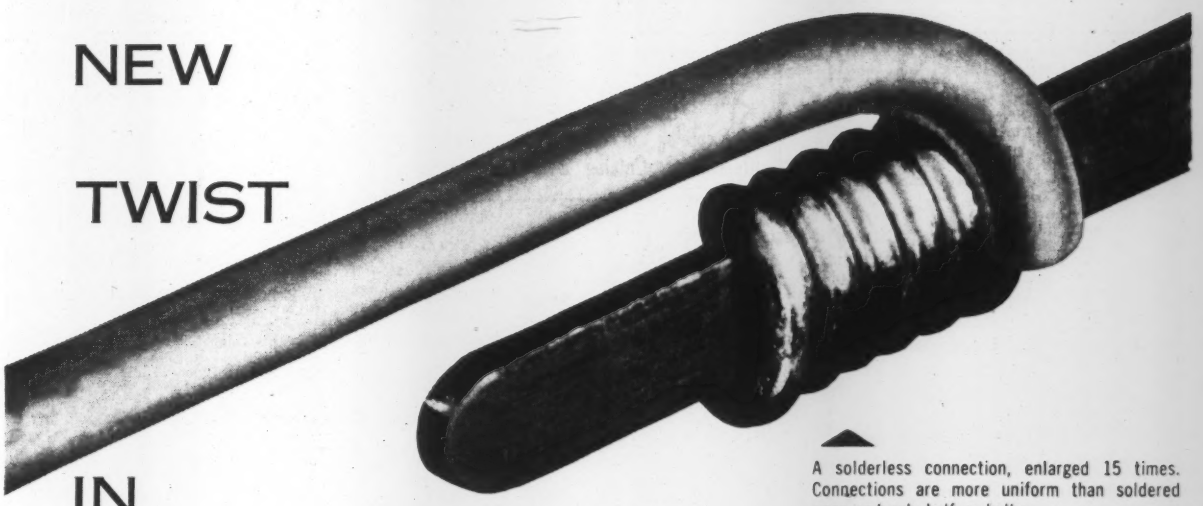
The **Kuljian** *Corporation*
ENGINEERS • CONSTRUCTORS • CONSULTANTS
POWER PLANT SPECIALISTS
UTILITY • INDUSTRIAL • CHEMICAL
1200 N. Broad St., Phila. 21, Pa.

An announcement in this section will acquaint others with your specialized practice.

ST &CO., INC.
APPLIED MECHANICS
Consulting • Inspection
Machine Shop • Laboratories
SAM TOUR & CO., INC.
44 Trinity Pl., N. Y. 6, N. Y.

The above consultants are available
to work out solutions
to your engineering and management problems.

A NEW TWIST IN TELEPHONY



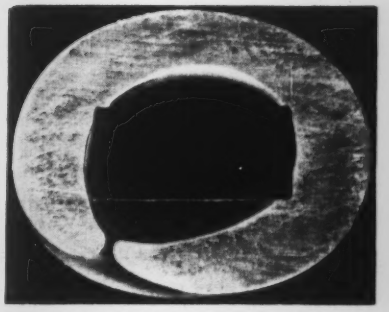
A solderless connection, enlarged 15 times. Connections are more uniform than soldered ones and only half as bulky.

For years the accepted way to connect wires to telephone apparatus was with solder. Now, Bell Laboratories engineers have discovered how to make connections faster and better—without solder.

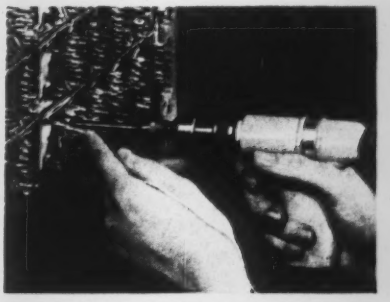
Solder, they reasoned, wouldn't be needed if wire and terminal could be kept tightly pressed together. But, for economy, this had to be done with the wire alone—without complicating screws and springs.

They found the answer in using a properly dimensioned terminal with sharp edges . . . whipping the wire around it under high tension. The terminal bites into the wire, locking it securely into position. Thereafter the squeezed edges maintain a contact pressure of at least 15,000 pounds per square inch—even under vibration that cracks soldered joints.

The new connections can be made in half the time—a big money-saver in the billion connections that Western Electric makes each year for the Bell System. It's another example of the way Bell Telephone Laboratories works continually to keep costs low.



Cross section of solderless connection. Note terminal biting into wire. In a six-turn connection there are at least 20 clean contact areas impervious to moisture and corrosive gases, offering current a low resistance path.



Power tool whips wire on terminal in fraction of a second. There is no heat which could damage miniature components . . . no dropped solder or wire clippings to cause trouble later.

BELL TELEPHONE LABORATORIES

IMPROVING TELEPHONE SERVICE FOR AMERICA PROVIDES CAREERS FOR CREATIVE MEN IN MECHANICAL ENGINEERING

Index To Advertisers

*Aetna Ball & Roller Bearing Co. 11
*Air Preheater Corp. 13
*Aldrich Pump Co. 71
All American Tool & Mfg. Co. 70
Allegheny Ludlum Steel Corp. 28
Aluminum Co. of America 42, 51
*American Blower Corp. 72
*American Brass Co. 147
American Cystoscope Makers (Inc.) 144
*American Felt Co. 153
Amplex Division
Chrysler Corporation 31
Arkwright Finishing Co. 44
ASME Publications 132, 146
Mechanical Catalog 106
*Associated Spring Corp. 17, 18
Aurora Pump Co. 64
*Bailey Meter Co. 2nd Cover
Bell Telephone Laboratories 155
Bigelow-Liptak Corp. 108
*Blaw-Knox Co.
Grating Dept. 70
Power Piping Div. 134
Brown & Sharpe 83
Bruning, Charles, Co. 50
Brush Electronics Co. 49
*Buffalo Forge Co. 15
Bundy Tubing Co. 33
*Chain Belt Co. 73
Chapman Valve Mfg. Co. 2
Chemical Industries Exposition 59
Cincinnati Gear Co. 67
Clark Equipment Co.
Industrial Truck Div. 45
*Cleaver-Brooks Co. 143
Climax Molybdenum Co. 52
*Cochrane Corp. 133
*Columbia-Geneva Steel Co. 92, 93
*Combustion Engineering (Inc.) 157
*Consolidated Chimney Co. 64
Consolidated Engineering Corp. 77
Coppus Engineering Corp. 29
*Denison Engineering Co. 56, 88
Detroit Harvester Co.
Pioneer Pump Div. 68
*Detroit Stoker Co. 37
DeZurik Shower Co. 146
Diamond Chain Co. (Inc.) 102
Diamond Power Specialty Corp. 118
Diefendorf Gear Corp. 136
Dow Corning Corp. 125, 126
*Downingtown Iron Works 46
*Dresser Industries (Inc.)
Pacific Pumps (Inc.) 61
Roots-Connersville Blower Div. 139
Drop Forging Association 57
Dudek & Bock Spring Mfg. Co. 140
DuMont, Allen B. Labs. 53
Earle Gear & Machine Co. 142
Eastman Kodak Co. 91
Edward Valves (Inc.)
Sub. Rockwell Mfg. Co. 87
*Elastic Stop Nut Corp. of America 127
*Engineer Co. 55
*Erie City Iron Works 111
Fairbanks, Morse & Co. 21
Fairmont Coal Bureau 67
*Farrel-Birmingham Co. (Inc.) 89
Farval Corp. 137
Fenwal (Inc.) 90
*Flexitallic Gasket Co. 39
*Flexonics Corp.
Chicago Metal Hose Div. 4
*Foote Bros. Gear & Machine Corp. 95
Ford Instrument Co., Div. Sperry Corp. 32
*Foxboro Co. 30
Fulton Sylphon, Div.
Robertshaw-Fulton Controls Co. 128
*Garlock Packing Co. 16
General Electric Co. 74, 75, 112, 113
General Radio Co. 12
*Goulds Pumps (Inc.) 47
Graphite Metallizing Corp. 66
*Grinnell Co. 123
Hathaway Instrument Co. 56
Hewlett-Packard Co. 48
*Hoffman Combustion Engrg. Co. 84, 85
Hunt, C. B. & Son 140
Hyatt Bearings Div., General Motors 6, 7
Imperial Tracing Cloth 142
International Nickel Co. 34
Irving Subway Grating Co. 65
*James, D. O., Gear Mfg. Co. 97
Jenkins Bros. 40
*Johns-Manville 107
Kellogg, M. W., Co. 5
Keuffel & Esser Co. 22, 23
*Kewanee-Ross Corp. 9
*Koppers Co., Fast's Coupling Dept. 121
Lefax 144
Lincoln Electric Co. 52
Linear (Inc.) 136
*Link-Belt Co. 141
Lord Mfg. Co. 26, 27
Lovejoy Flexible Coupling Co. 138
*Lummus Co.
Western Piping Supply Co. 69
Midwest Piping Co. (Inc.) 119
Nagle Pumps (Inc.) 55
*National Airoil Burner Co. 56
New Departure Div., General Motors 1
*Newport News Shipbuilding & Dry Dock Co. 94
New York Air Brake Co. 145
Nicholson, W. H. & Co. 54
North American Aviation (Inc.) 124
Northern Blower Co. 43
Ohio Gear Co. 134
Olson, Arthur A. & Co. 68
Pacific Pumps (Inc.) 61
Parker White-Metal Co. 96
Peerless Photo Products (Inc.) 10
*Peerless Pump Div.
Food Machy. & Chemical Corp. 138
Permutit Co. 3rd Cover
Philadelphia Gear Works 158
Photoswitch (Inc.) 122
Pittsburgh Lectrodryer Corp. 86
*Powers Regulator Co. 104, 105
*R-S Products Corp. 14
Ray Oil Burner Co. 9
Reliance Electric & Engrg. Co. 130
*Republic Flow Meters Co. 129
Research Corp. 54
Revere Copper & Brass (Inc.) 148
Rockford Clutch Div.
Borg-Warner Corp. 142
*Rockwell Mfg. Co.
Nordstrom Valves Div. 81, 82
Ronald Press Co. 60
*Roots-Connersville Blower Div.
Dresser Industries (Inc.) 139
Rust-Oleum Corp. 135
*SKF Industries (Inc.) 24
*Seamlex Co. 142
Sponge Rubber Products Co. 98
Spraying Systems Co. 69
Streeter-Amet Co. 134
*Taylor Forge & Pipe Works 110
*Taylor Instrument Cos. 114
*Tennessee Coal & Iron Div. 92, 93
*Terry Steam Turbine Co. 19
Thomas Flexible Coupling Co. 66
*Timken Roller Bearing Co. 4th Cover
Trabon Enbineering Corp. 115
Trane Co. 101
*Tube Turns (Inc.) 99, 100
*United States Steel Co. 92, 93
*United States Export Co. 92, 93
Vickers (Inc.) Div. Sperry Corp. 103
*Vogt, Henry, Machine Co. 20
*Voss, J. H. H., Co. 146
Waldes Kohinoor (Inc.) 25
Walworth Co. 116
Waterman Engineering Co. 140
*Western Gear Works 120
*Westinghouse Electric Corp. 78, 79, 109
Westinghouse Electric Corp.
Sturtevant Div. 8
*Wickes Boiler Co., Div. Wickes Corp. 117
Wiegand, Edwin L., Co. 60
Williams Gauge Co. 58
*Wing, L. J., Mfg. Co. 63
Wisconsin Motor Corp. 59
Wolverine Tube Div.
Calumet & Hecla (Inc.) 131
*Yarnall-Waring Co. 35
Yoder Co. 3

★ The asterisk indicates that firm also has product catalog in the 1954 ASME Mechanical Catalog and Directory

CONSULTING SERVICE . . . Page 154

Black & Veatch
Electrical Testing Laboratories
Harza Engineering Co.
Hathaway, C. M.
Jackson & Moreland
Kendall, George H.
Kuljian Corp.
Loftus, Peter F., Corp.
Marquette Coppersmithing Co.
Mast Development Co.
National Weld Testing Bureau
Nuclear Development Assoc.
Palmer, Delos M. & Assoc.
Polachek, Z. H.
Sanderson & Porter
Sargent & Lundy
Sirrine, J. E., Co.
Stanley Engineering Co.
Thompson, John I. & Co.
Tour, Sam & Co.

Advertisers in Previous 1953 issues but not in this issue

*Allis-Chalmers Mfg. Co.
American Flexible Coupling Co.
*American Manganese Bronze Co.
American Fen II Co.
*American Pulverizer Co.
*Armstrong Machine Works
Automotive & Aircraft Div.
American Chain & Cable Co.

*Babcock & Wilcox Co.
*Barco Manufacturing Co.
Bellows Co.
Biddle, James G., Co.
Boston Gear Works
Briggs & Stratton Corp.
Brown Boveri Corp.
Burgess-Manning

Carborundum Co.
Catalytic Combustion Corp.
Centriline Corp.
Chace, W. M., Co.
Chelsea Fan & Blower Co.
Chiksan Co.
Clarage Fan Co.
Clark Bros. Co.
Cleveland Worm & Gear Co.
*Coffin, J. S., Jr., Co.
Cone-Drive Gear Div.
Michigan Tool Co.
Cratex Mfg. Co.
Cuno Engineering Corp.

*Dravo Corp., Heating Dept.

Eagle Pencil Co.
Elliott Mfg. Co.
Ellison Draft Gage Co.

Fafnir Bearing Co.
*Falk Corp.
Fiske Bros. Refining Co.
Lubriplate Div.
Flatto Management Co.
Flexo Supply Co.

*Gear Specialties (Inc.)
Gerotor May Corp.
Giannini, G. M. & Co.

Hagan Corp.
Hamilton Mfg. Co.
Hankison Corp.
Harper, H. M., Co.
Helicoid Gage Div.
American Chain & Cable
Henschel John & Co.
Higgins Ink Co.
*Homestead Valve Mfg. Co.
*Hydropress (Inc.)

*Illinois Gear & Machine Co.
Instrof Corp.
Insul-Mastic Corp. of America
Iron Fireman Mfg. Co.

Johnson, Carlyle, Machine Co.
Johnson-March Corp.

*Keckley, O. C., Co.
Kennametal (Inc.)
*Koppers Co.
Piston Ring Dept.
Tar Products Div.

*Ladish Co.
Ledeen Mfg. Co.
Lenape Hydraulic Pressing & Forging Co.
*Leslie Co.
Little, Arthur D. (Inc.)
Lubriplate Div.
Fiske Bros. Refining Co.
Lukens Steel Co.
Lunkenheimer Co.

MB Manufacturing Co.
Marsh Instrument Co.
*Mercoid Corp.
Morse Chain Co.
Murphy, Jas. A. & Co.

Noone Industrial Fabrics
Div. Kenwood Mills

Ohio Injector Co.
*Oilgear Co.
O'Neil-Irwin Mfg. Co.

*Pangborn Corp.
Parker Appliance Co.
*Peabody Engineering Corp.
*Pennsylvania Pump & Compressor Co.
Petro
Pittsburgh Piping & Equipment Co.
*Posey Iron Works (Inc.)
Post, Frederick, Co.

Read Standard Corp.
Reeves Pulley Co.
Reliance Gauge Column Co.
Resolite Corp.
Ric-Wil Co.

*Sarco Co.
*Schutte & Koerting Co.
Servel (Inc.)
*Shafer Bearing Co.
*Sier-Bath Gear & Pump Co.
*Spence Engineering Co.
Standard Locknut & Lockwasher
Sterling Electric Motors (Inc.)
Sturtevant, P. A., Co.

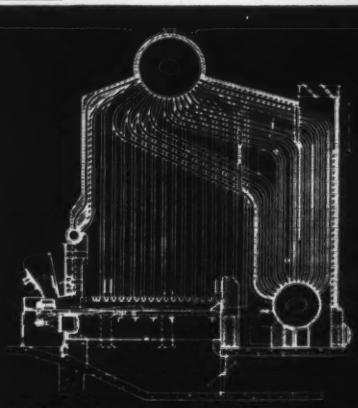
Taylor Dynamometer & Machine Co.
Trimount Instrument Co.

Uniflow Mfg. Co.

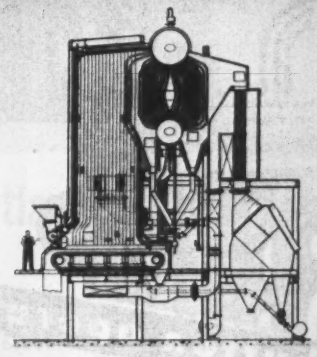
Valvair Corp.

*Westinghouse Air Brake Co
Wheeler, C. H., Mfg. Co.
Wiley, John & Sons
Winsmith (Inc.)

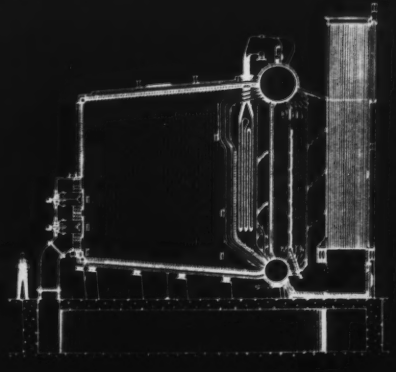
*Zallea Brothers
Zurn, J. A., Mfg. Co.



VU-10 Boiler — This unit is installed in a hosiery mill. It is fired by a Type E Underfeed Stoker. Capacity — 12,500 lb steam per hr; operating pressure — 100 psi; no superheat. VU-10 Boilers are available in sizes from 10,000 to 60,000 lb of steam per hr.



VU-40 Unit — One of seven, recently installed in a Chemical Plant. These boilers are fired with C-E Spreader Stokers (continuous discharge type). The capacity of each is 60,000 lb of steam per hr at an operating pressure of 325 psi. There is no superheat.



VU-50 Boiler — This unit is one of two duplicates installed in a brewery. They are fired with oil or gas. Capacity — 100,000 lb of steam per hr; operating pressure 550 psi; steam temperature 700 F. This particular design is of the bottom-supported type.

VU Utility Standards in a Standard Boiler

Electric utility companies maintain the highest equipment standards in the power generation field. Kilowatts are their business — their product... to be turned out reliably, efficiently and at the lowest possible cost. To assure this they demand — and get — the most reliable — the most efficient — the best built boilers that the market affords.

To meet their highly critical standards the utilities have long been accustomed to purchase steam generating units that were, in large measure, individually designed to meet their particular needs. And C-E Vertical-Unit Boilers, particularly in the larger sizes, are available in "custom-made" designs to suit specific requirements. In fact, VU Units have been a popular choice with utility companies for many years.

But many other designs that comprise the "VU family" are completely *standardized*...standardized without sacrifice of "custom-made" advantages. And when you standardize you reduce engineering costs, reduce manufacturing costs, reduce erection costs — in short, you save money.

Here then is a line of custom-quality boilers with all the benefits of standardization built in capacities from 10,000 lb of steam per hr up, for any pressure and temperature...and suitable for any type of fuel burning equipment.

Little wonder that industry — all industry — has found within the VU family a boiler unit exactly suited to its needs. Breweries and hosiery mills, chemical companies and steel plants — all have installed VU Boilers again and again with complete satisfaction. So can you.

B-649A

COMBUSTION ENGINEERING, INC.

Combustion Engineering Building

200 Madison Avenue, New York 16, N. Y.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT

Pushing a Button

is SAFER EASIER QUICKER

LIMITORQUE®

push button operation

LimiTorque opens and closes any type of valve in a fraction of the time required for hand operation. It is *absolutely dependable and safe,* even when pressures are so *high* that manual operation is almost impossible . . . when valves are exceptionally *hot* . . . and where its location is *hazardous* or *inaccessible.*

Thousands upon thousands of these "time-tried and tested" *Valve Operators* are in continuous use, all over the world.

Of course, *LimiTorque* offers a number of "exclusive advantages" in design and construction, which not only give dependable, safe and speedy performance, but which are your *guarantee* against damage to valve stems, seats, discs, plugs, or gates . . . not to mention possible physical injury to operators.

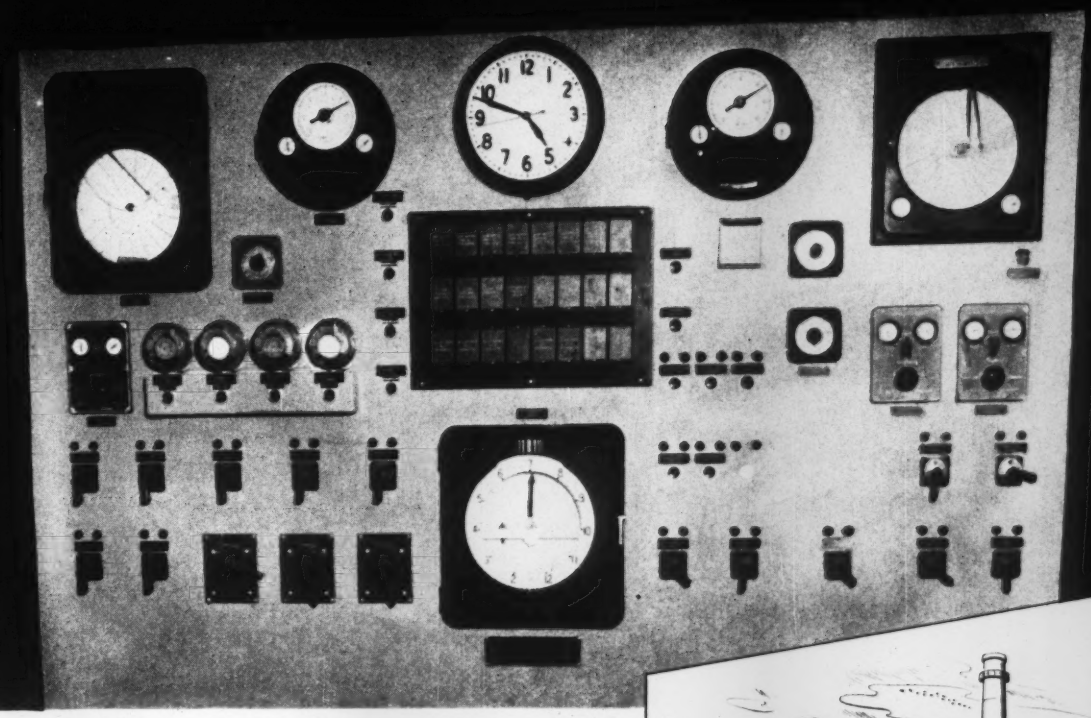
If you have *valve operating problems,* write us —and a "Philadelphia Engineer" will gladly call.

Philadelphia Gear Works, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.

NEW YORK · PITTSBURGH · CHICAGO · HOUSTON · LYNCHBURG, VA.

Industrial Gears and Speed Reducers
LimiTorque Valve Controls



Atlantic City Electric Company selects PERMUTIT WATER CONDITIONING with *centralized, automatic control*

Greenwich Station. Normal steam capacity: 460,000 lb per hr. Engineered and constructed by Burns and Roe, Inc., New York City.

TO FILL *changing* demand for 100% makeup with highest purity feedwater requires the best of equipment and a degree of efficiency obtainable only with modern automatic control.

At the Greenwich Station, instrumentation — centralized in Permutit cubicles — provides this control. The water-treatment plant supplies makeup that meets requirements for two 650 psig boilers operating under *wide ranges* in load . . . for steam output and turbo-generator exhaust must also fill the changing process-steam needs of a very large, nearby chemical plant.

TREATMENT METHODS SPECIFIED

Consulting engineers investigated several plans to determine the most efficient and economical means of making Delaware River water satisfactory for two 230,000 lb per hr boilers. Final decision was to treat the water with *Permutit equipment:* coagulation, silica reduction, filtration, hydrogen-sodium-zeolite softening, degasification . . . with provision for demineralization if required.

REQUIREMENTS FOR COMPLETE CONTROL

Mounted on the Permutit central control board are flow controllers and loss of head gauges for each filter; flow recorders, level indicators, alarms, timing devices, etc. A pH indicator assures proper blending of the sodium and hydrogen-zeolite softened waters. After setting flow rates, timing elements, etc., this entire Permutit water-treatment system operates *automatically!*

FIND out how Permutit can solve your water problems. Write to THE PERMUTIT COMPANY, Dept. ME-10, 330 West 42nd Street, New York 36, N. Y. or Permutit Company of Canada, Ltd., 6975 Jeanne Mance Street, Montreal.

PERMUTIT®

ION EXCHANGE AND WATER CONDITIONING HEADQUARTERS FOR OVER 40 YEARS

Faces, contours, bores and turns big, short-length parts automatically . . . *with help of TIMKEN® bearings*

HERE'S a lathe that makes jet engine parts of awkward shape and unwieldy size—parts that ordinary lathes can't handle with full efficiency. It's the Monarch Model 0 60″ Right Angle Lathe. Automatic control gives it greater production. The Timken® bearings on its spindle give it the extremely high accuracy required for jet engine parts.

Spindle rigidity and accuracy essential for the high precision work of this Monarch Lathe are maintained with Timken precision tapered roller bearings.

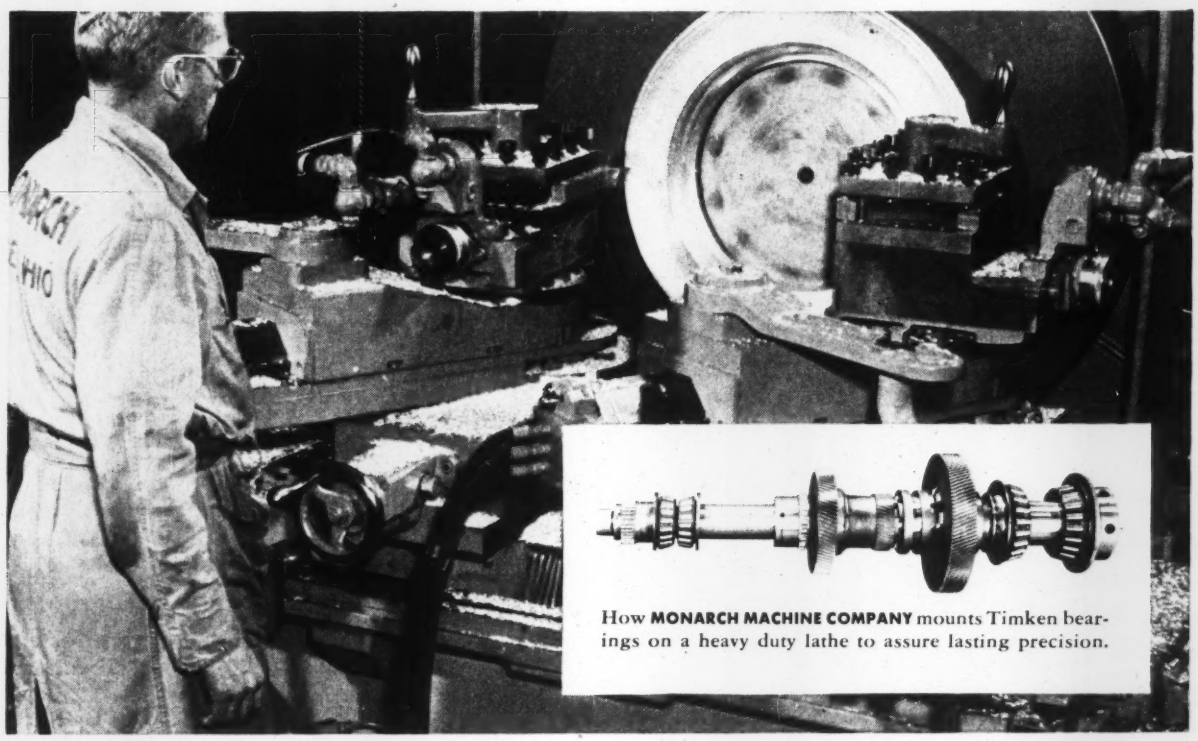
Timken precision bearings are made specially for spindle applications. Runout tolerances can be held to a maximum of 75 millionths of an inch.

The tapered design of Timken precision bearings enables them to take radial and thrust loads in any combination, holds spindles rigid and permits pre-loading to any desired degree to prevent chatter.

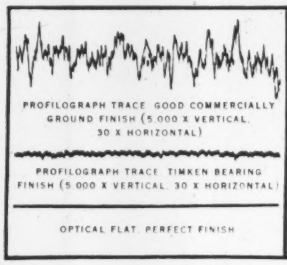
True rolling motion and an incredibly smooth surface finish combine to make Timken bearings practically friction free. They're made from Timken fine alloy steel—finest steel ever developed for tapered roller bearings—and rollers and races are case-hardened for hard, wear-resistant surfaces and tough, shock-resistant cores.

Next time you buy or build a machine tool, be sure it's equipped with Timken precision tapered roller bearings. Always look for the trademark "Timken" stamped on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

TIMKEN BEARING EQUIPPED — *This symbol on a product means its bearings are the best.*



How **MONARCH MACHINE COMPANY** mounts Timken bearings on a heavy duty lathe to assure lasting precision.


PROFILOGRAPH TRACE, GOOD COMMERCIALLY GROUND FINISH (5,000 X VERTICAL, 30 X HORIZONTAL)
PROFILOGRAPH TRACE, TIMKEN BEARING FINISH (5,000 X VERTICAL, 30 X HORIZONTAL)
OPTICAL FLAT, PERFECT FINISH

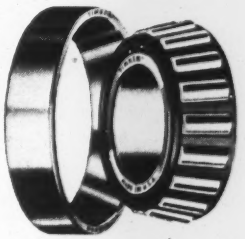
SMOOTH TO MILLIONTHS OF AN INCH

Surface finish of high quality Timken bearing rollers and races is so smooth that it takes a profilograph to measure its smoothness. This instrument measures surface variations to a millionth of an inch, as shown at the left.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◎ AND THRUST →◎← LOADS OR ANY COMBINATION →✳←